LEVEL II

AFHRL-TR-80-29

AIR FORCE HUMAN RESOURCES

AD A093353

# HUMAN RESOURCES, LOGISTICS, AND COST FACTORS IN WEAPON SYSTEM DEVELOPMENT: METHODOLOGY AND DATA REQUIREMENTS


By

Gerard F. King
Dynamics Research Corporation
60 Concord Street
Wilmington, Massachusetts 01887

William B. Askren

LOGISTICS AND TECHNICAL TRAINING DIVISION
Wright-Patterson Air Force Base, Ohio 45433




November 1980

Final Report

Approved for public release; distribution unlimited.



LABORATORY

AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

## NOTICE

When U.S. Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This final report was submitted by Dynamics Research Corporation, 60 Concord Street, Wilmington, Massachusetts 01887, under Contract F33615-77-C-0016, Project 1959, with the Logistics and Technical Training Division, Air Force Human Resources Laboratory (AFSC), Wright-Patterson Air Force Base, Ohio 45433. Dr. William B. Askren was the Work Unit Scientist for the Laboratory.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

ROSS L. MORGAN, Technical Director
Logistics and Technical Training Division

RONALD W. TERRY, Colonel, USAF
Commander

~~SUBJECT TO EXPORT CONTROL LAWS~~

~~This document contains information for manufacturing or using munitions of war. Export of the information contained herein, or release to foreign nationals within the United States, without first obtaining an export license, is a violation of the International Traffic in Arms Regulations. Such violation is subject to a penalty of up to 2 years imprisonment and a fine of $100,000 under 22 U.S.C. 2778.~~

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| (19) REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|---|---|
| 1. REPORT NUMBER<br>(18) AFHRL-TR-80-29 | 2. GOVT ACCESSION NO.<br>AD-A093 | 3. RECIPIENT'S CATALOG NUMBER<br>353 |
| 4. TITLE (and Subtitle)<br>Human Resources, Logistics, and Cost Factors in Weapon System Development: Methodology and Data Requirements | | 5. TYPE OF REPORT & PERIOD COVERED<br>(9) Final repto |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s)<br>(10) Gerald F. King<br>William B. Askren | (12) 188 | 8. CONTRACT OR GRANT NUMBER(s)<br>(15) F33615-77-C-0016 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Dynamics Research Corporation<br>60 Concord Street<br>Wilmington, Massachusetts 01887 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS<br>63451F<br>(16) 19590002 (17) 00 |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>HQ Air Force Human Resources Laboratory (AFSC)<br>Brooks Air Force Base, Texas 78235 | (11) | 12. REPORT DATE<br>November 1980 |
| | | 13. NUMBER OF PAGES<br>190 |
| 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)<br>Logistics and Technical Training Division<br>Air Force Human Resources Laboratory<br>Wright-Patterson Air Force Base, Ohio 45433 | | 15. SECURITY CLASS. (of this report)<br>Unclassified |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

consolidated data base
coordinated human resource technology
design option decision trees
human resource in design tradeoffs
instructional system development
job guide development
life cycle costing
logistic support elements
maintenance manpower modeling
system ownership costing
task analysis
technical manuals
training
weapon system acquisition

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes a methodology which is useful for applying human resources, logistics, and cost factors in weapon system acquisition programs. The methodology, termed the coordinated human resources technology (CHRT), was developed from an integration of five individual human resources technologies: maintenance manpower modeling, instructional system development, job guide development, human resources in design tradeoffs, and system ownership costing. The CHRT methodology operates from a consolidated data base (CDB) which integrates data from these five technologies into a single data source. The CHRT methodology has two distinct capabilities: (a) it can assess the impact of baseline and alternative equipment designs and support plans on human resources, logistics, and ownership costs, and (b) it can provide an integrated maintenance personnel, training, and technical manual program for the system. The CHRT methodology is implemented by a number of computer operated models, manual operated models, and

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

388102 JK

20 ABSTRACT (Cont)

task analysis procedures. The CDB has both computer data files and hard copy data files. The description of the CHRT and the CDB is based upon a conceptual structure and the results of a preliminary tryout of the conceptual structure using data from the Advanced Medium STOL* Transport System acquisition program.

*STOL - short takeoff and landing

| Accession For | |
|---|---|
| NTIS GRA&I | X |
| DTIC TAB | ☐ |
| Unannounced | ☐ |
| Justification | |
| By | |
| Distribution/ | |
| Availability Codes | |
| Dist | Avail and/or Special |
| A | |

## SUMMARY

### PROBLEM AND OBJECTIVE

There are five human resource technologies useful in developing weapon systems which meet the operational objectives at the lowest possible support costs. These technologies are maintenance manpower modeling (MMM), instructional system development (ISD), job guide development (JGD), system ownership costing (SOC), and human resources in design trade-offs (HRDT). In the past, these technologies either have not been applied at all or have been applied individually at various times during the weapon system acquisition process. This has resulted in redundancies in data requirements and a fragmented approach to design for supportability and support planning.

A coordinated human resource technology (CHRT) and a supporting consolidated data base (CDB) concept have been developed to provide more integrated and effective use of these five technologies in weapon system development. The CHRT methodology, and CDB requirements, as originally conceived, are documented in the Air Force Human Resources Laboratory Technical Report AFHRL-TR-78-6, Volumes I, II, and III. The CHRT and the CDB, as described in those initial reports, have since had a preliminary demonstration in a weapon system acquisition program. The results of this demonstration are documented in AFHRL-TR-79-28, Volumes I and II, and AFHRL-TR-80-52, Volumes I and II.

The objective of this report is to provide an updated description of the CHRT and the CDB, which reflects the original conceptual structure and the experience gained during the preliminary demonstration. This report details the CHRT methodology and the CDB.

### DESCRIPTION OF THE CHRT AND CDB

The description of the CHRT and the CDB is based on a conceptual structure and on the results of a preliminary tryout of the conceptual structure using data from the advanced medium

STOL[1] transport (AMST) system acquisition program. The CHRT methodology was developed from an integration of five individual human resources technologies. The CHRT operates from a consolidated data base that integrates data from these five technologies and stores the data in a single source. The CHRT methodology has two distinct capabilities: (a) it can assess the impact of baseline and alternative equipment designs and support plans on human resources, logistics, and ownership costs, and (b) it can provide an integrated maintenance personnel, training, and technical manual program for the system. The CHRT methodology is implemented by a number of computer operated models, manual operated models, and task analysis procedures. The CDB has both computer data files and hard copy data files.

The CHRT methodology includes six analytical activities, 16 data generation operations, and two types of output products. The analytical activities are:

1. Program definition, comparability analysis, and task analysis.
2. Cost data bank preparation.
3. Logistics resource assessment.
4. Life cycle cost assessment.
5. Impact assessment.
6. Product development.

The data generation operations produce:

1. System program requirements.
2. System design characteristics.
3. Support plans.
4. Maintenance requirements and tasks.
5. Operations requirements and tasks.

---

[1] short takeoff and landing

6. Design and support plan alternatives.

7. Cost and cost-related data.

8. LCOM Model outputs.

9. EVM Model outputs.

10. R&M Model outputs.

11. Operations and support estimates.

12. Training Estimates.

13. Technical manual estimates.

14. Training/aiding matrices.

15. Intermediate products for training program/technical manual development.

16. Life cycle cost estimates.

The output products are:

1. Assessments of baseline and alternative designs and support plans.

2. Coordinated maintenance training programs and technical manuals.

## CONCLUSIONS

The CHRT methodology can be described as a straightforward, step-by-step process applicable with continuity throughout all phases of weapon system acquisition. The CHRT methodology and the concept of the CDB are especially useful during early phases of system acquisition as a tool to assist in system design and support planning. The CHRT is directly compatible with the weapon system acquisition process. It also supports the determination of several of the integrated logistics support elements. Although no demonstration test was conducted, it is believed that the CHRT methodology and the CDB concept are as applicable to modifications of existing systems as they are to new acquisitions.

## PREFACE

This study was performed by Dynamics Research Corporation (DRC), 60 Concord Street, Wilmington, Massachusetts. Technical direction was provided by the Logistics and Technical Training Division, Air Force Human Resources Laboratory (AFHRL), Wright-Patterson Air Force Base, Ohio.

The AFHRL support was provided under project 1959, Advanced Systems for Human Resources Support of Weapon Systems Development, Lieutenant Colonel John Adams, Project Director, and work unit 1959-00-02, Integration and Application of Human Resource Technologies in Weapon System Design, Dr. William B. Askren, Work Unit Scientist.

The Advanced Systems Department staff at Dynamics Research Corporation performed the research under contract F33615-77-C-0016 with Mr. Gerard F. King as Principal Investigator.

Many individuals throughout the Department of Defense and industry contributed their ideas and opinions to this effort. Of special note, however, were the members of the AFHRL Logistics and Technical Training Division who contributed both in their specific areas of expertise and in the total development of CHRT. These individuals and their areas of expertise are Mr. Robert N. Deem, maintenance manpower modeling; Dr. Garry A. Klein, instructional system development; Dr. Donald L. Thomas, job guide development; Mr. Harry A. Baran, system ownership costing; and, Dr. Lawrence E. Reed, consolidated data base. Lieutenant Colonel Dalton Wirtanen and Major Robert J. Pucik of the AMST Program Office provided the interface with the AMST acquisition effort. Appreciation is also extended to Dr. John P. Foley, Jr. for sharing his view of job guide development and the instructional system/job guide relationship.

Dr. Paul G. Ronco and Dr. John A. Hansen of Man-Tech Incorporated, a DRC subcontractor, provided significant contributions in the development, demonstration, and implementation of the integrated personnel, training, and technical manual approach. Specifically, they prepared the major portion of the intermediate training and technical manual products, performed on the on-equipment task analysis, and drafted the sample training plan and technical manual.

HUMAN RESOURCES, LOGISTICS, AND COST FACTORS IN WEAPON SYSTEM DEVELOPMENT: METHODOLOGY AND DATA REQUIREMENTS

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (concluded)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (concluded)

# HUMAN RESOURCES, LOGISTICS, AND COST FACTORS IN WEAPON SYSTEM DEVELOPMENT: METHODOLOGY AND DATA REQUIREMENTS

## I. INTRODUCTION

The Department of Defense (DOD) desires to reduce weapon system operating and support (O&S) costs. To achieve this goal, each military service has been required to incorporate cost-saving measures and to make quantitative assessment of O&S costs. This requirement has been applied to both weapon systems under development and to major modifications of existing weapon systems.

There are five human resource technologies which are useful in helping a developing weapon system meet this goal: maintenance manpower modeling (MMM), job guide development (JGD), instructional system development (ISD), system ownership costing (SOC), and human resources in design trade-offs (HRDT). The terms job guide and instructional system as used in this report are generally synonymous to technical manuals and training, respectively. Each of the five technologies has an assessment and/or product development function. The assessment function is appropriate to quantifying the system design and support plan impact on human resources, logistics, and costs. The product development function is related to the development of a coordinated training program and technical manual set, and manpower estimates.

In the past, these technologies either have not been applied at all or have been applied individually at various times during the weapon system acquisition process. This has resulted in redundancies in data requirements and a fragmented approach to design for supportability and support planning. It appeared that, if these technologies were integrated systematically, greater efficiency and accuracy in human resources, logistics, and cost assessment could be achieved, and a mutually supportive and coordinated training program and technical manual set could be developed for a given weapon system. With this in mind, a two-phase study effort was initiated in March 1977 to integrate and apply the five technologies.

During the development phase of the study, Phase I, the initial coordinated human resource technology (CHRT) was developed. The five technologies were integrated and a methodology for application was produced. Phase I also resulted in the description of a consolidated data base (CDB) which would service the CHRT and eliminate the need for separate data bases to service each distinct technology. The concept, methodology, and data base were initially documented in the following reports.

AFHRL-TR-78-6 (I) Integration and Application of Human Resource Technologies in Weapon System Design: Coordination of Five Human Resource Technologies.

AFHRL-TR-78-6 (II) Integration and Application of Human Resource Technologies in Weapon System Design: Processes for the Coordinated Application of Five Human Resource Technologies.

AFHRL-TR-78-6 (III) Integration and Application of Human Resource Technologies in Weapon System Design: Consolidated Data Base Functional Specification.

During the demonstration phase, Phase II, the CHRT and the CDB were applied in three successive acquisition phases using data from the advanced medium STOL (short takeoff and landing) transport (AMST) acquistion program. The objective of Phase II was to determine the applicability of both the CHRT and its related CDB in each phase of acquistiion. The feedback provided from the Phase II effort made it possible to refine and expand the initial CHRT and CDB concepts. The results of the demonstration are documented in the following reports.

AFHRL-TR-79-28 (I) Human Resources, Logistics, and Cost Factors in Weapon System Development: Demonstration in Conceptual and Validation Phases of Aircraft System Acquisition.

AFHRL-TR-79-28 (II) Human Resources, Logistics, and Cost Factors in Weapon System Development: Demonstration in Conceptual and Validation Phases of Aircraft System Acquisition. Appendix A.

| | | |
|---|---|---|
| AFHRL-TR-80-52 | (I) | Human Resources, Logistics, and Cost Factors in Weapon System Development: Demonstration in the Full Scale Development Phase of Aircraft System Acquisition. |
| AFHRL-TR-80-52 | (II) | Human Resources, Logistics, and Cost Factors in Weapon System Development: Demonstration in the Full Scale Development Phase of Aircraft System Acquisition. Appendix A. |

This report describes the CHRT methodology and its related CDB as refined after the preliminary application in the AMST program. The purpose of this report is to provide a detailed description of the CHRT and the CDB. Section II contains the background material needed to understand the development of the CHRT. Section III provides a brief overview of the CHRT methodology and its related CDB. Section III also describes the initial CHRT data source requirements. The next several sections contain detailed descriptions of the individual CHRT activities and CDB data groups.

In addition, a summary of the entire effort is provided in:

| | |
|---|---|
| AFHRL-TR-80-8 | Human Resources, Logistics, and Cost Factors in Weapon System Development: Project Summary. |

## II. CONCEPT OF FIVE INTEGRATED HUMAN RESOURCE TECHNOLOGIES AND A SUPPORTING CONSOLIDATED DATA BASE

### 2.1 NEED FOR HUMAN RESOURCE, LOGISTICS, AND COST ASSESSMENT

Human resources include factors such as manpower quantities, types of personnel skills, skill levels, training, and technical manual requirements. These factors constitute a significant portion of both DOD spending and O&S costs. In fact, it has been estimated by the U.S. Commision on Defense Manpower[2] that nearly 60 percent of the weapon system total life cycle costs are attributable to these human resource requirements. Costs attributable to logistics requirements (such as maintenance concept, support equipment, and spares) increase this value to nearly 70 percent. In view of this, it is clear that no assessment of weapon system O&S costs can be considered complete until a systematic evaluation of the impacts of human resource and logistic requirements has been conducted.

### 2.2 TRADITIONAL APPLICATION OF THE FIVE HUMAN RESOURCE TECHNOLOGIES

This study first considered the traditional application of the five technologies to determine how they might be more effectively used and applied as an integrated methodology. The technologies considered are defined as follows.

MMM (maintenance manpower modeling) is a technique for estimating the maintenance manpower requirements for aircraft systems. This technology uses the logistics composite model (LCOM) to simulate the maintenance system in the form of maintenance action networks.

ISD (instructional system development) is a deliberate and orderly process for planning and developing instructional programs which insure that personnel are taught the knowledge, and skills essential for successful job performance (AFP 50-58).

---

[2] U.S. Commission on Defense Manpower. Defense Manpower: The Keystone of National Security. Report to the President and to Congress, April 1976.

JGD (job guide development) is a method of developing a broad range of troubleshooting and nontroubleshooting technical manuals designed to reduce training time and/or the skill required to perform a task.

SOC (system ownership costing) is a systematic method of estimating both the nonrecurring support investment and the recurring operating and support costs and identifying major cost contributors.

HRDT (human resources in design trade-offs) is an approach using design option decision trees (DODTs) to identify critical design trade-offs and then using human resource impact analysis to quantify the effect of the trade-off.

In the past, these technologies either have not been applied at all or have been applied individually at various times during the weapon system acquisition process. This application is depicted in Figure 1 and is summarized as follows.

MMM has been applied to various aircraft systems during the validation and full-scale development phases to predict system maintenance manpower requirements. The LCOM simulation based on maintenance action networks has been used as the mechanism for the analysis.

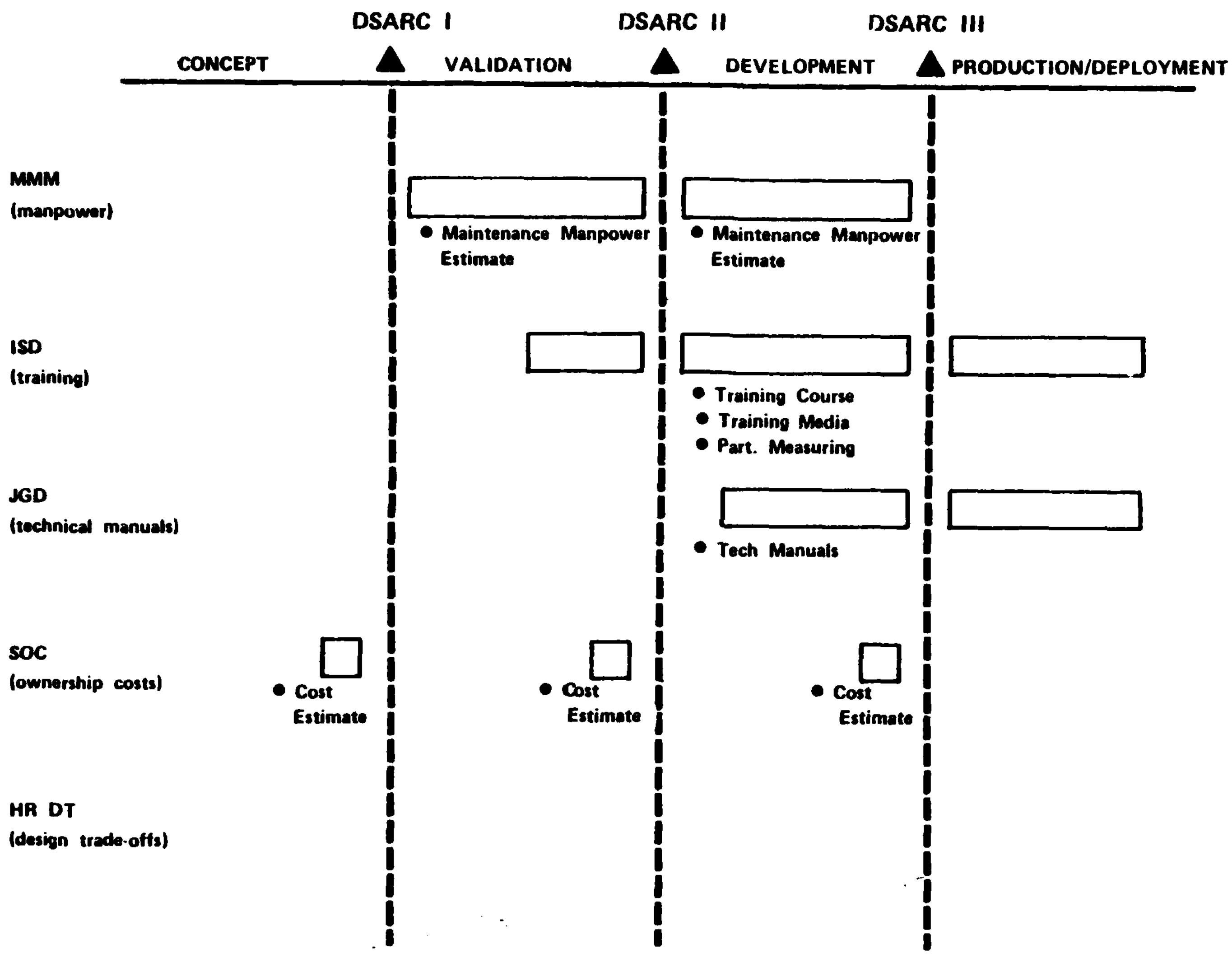
ISD as a decision-making process is applied late in the validation phase to define the training program. The applicability of technical manuals, a rarely-accomplished determination, is the only coordinated ISD/JGD activity. ISD as a product development process then continues through full-scale development into production/deployment.

JGD is initiated during full-scale development as a product development effort resulting in technical manuals. During the course of its associated task analysis, a reconsideration of the training/support equipment/technical manual mix is made.

SOC is not presently a rigorous technology but rather a Defense Systems Acquistiion Review Council (DSARC) milestone requirement. It is normally responded to with a point cost estimate. Equations and models for obtaining these estimates are not standardized, and the sources of data do not always adequately reflect the system being costed.

HRDT exists as the DODT technique and as a concept of using human resource data in design trade-offs. Feasibility studies indicate that it can be applied at many levels of detail throughout system acquisition. However, it has not actually been applied in acquisition. Additionally, there is no standardized

Figure 1 TRADITIONAL HUMAN RESOURCE TECHNOLOGY APPLICATION



technique for interfacing HRDT with the other technologies to obtain the human resources, logistics, and cost data associated with the system design and support planning alternatives.

## 2.3 INTEGRATED APPLICATION OF THE FIVE TECHNOLOGIES IN THE CHRT

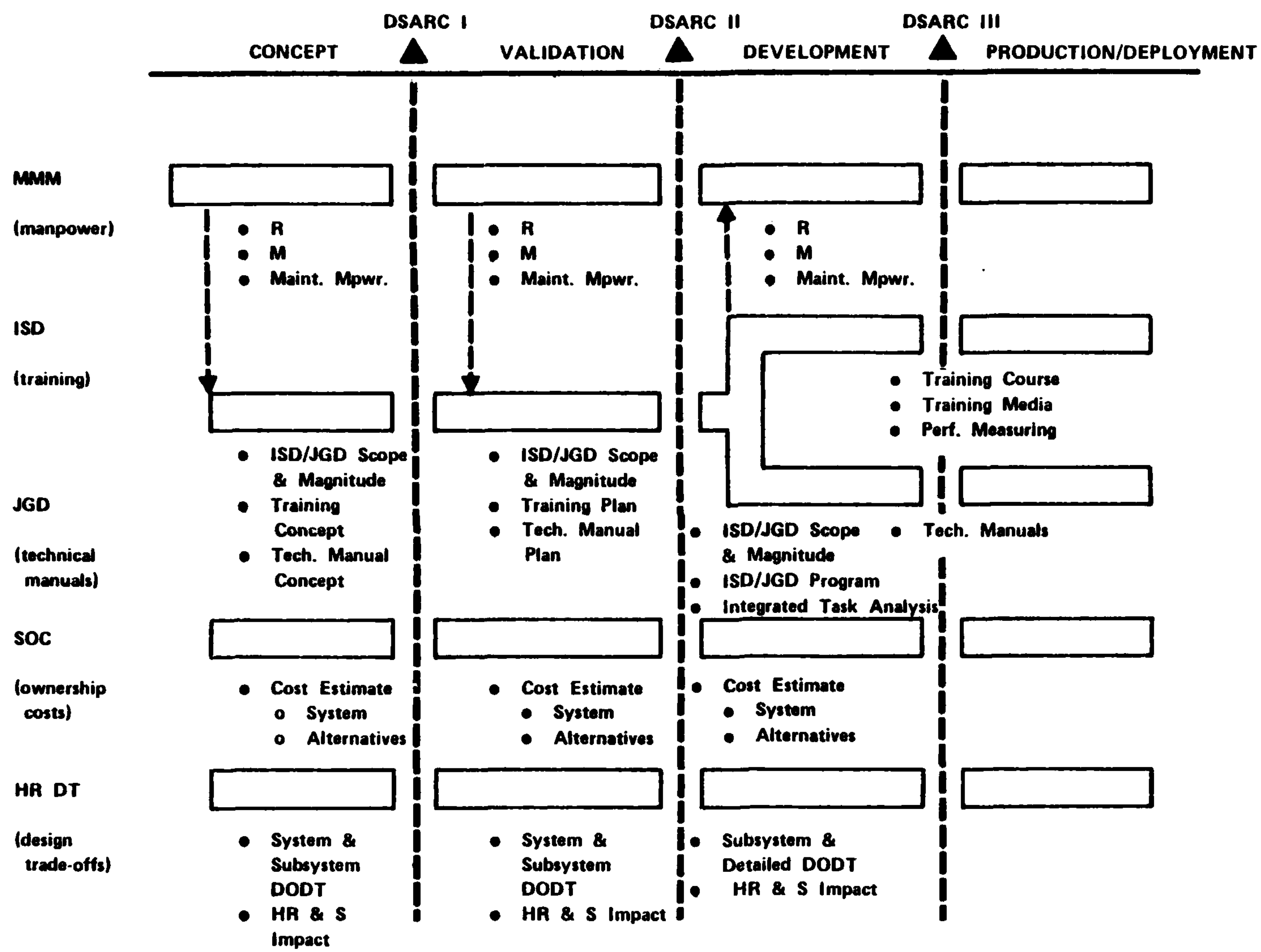
The CHRT integrates the five technologies for application throughout weapon system acquisition. As an assessment methodology, the CHRT is used to quantify the human resource, logistics, and cost impact of system design and support plans. As a product development methodology, the CHRT is used to develop a coordinated training plan and technical manual set tailored to the user population. Input for these technologies is provided by a CDB established and maintained for the weapon system under consideration.

Figure 2 outlines the applications of the human resource technologies extended and integrated as CHRT. These applications are described as follows.

MMM is initiated in the concept phase and updated during the validation and full-scale development phases. During the conceptual phase, a preliminary maintenance task analysis is performed using historical data from comparable systems. Maintenance action networks are then prepared. In lieu of the LCOM, the reliability and maintainability (R&M) model is used to investigate maintenance manpower and support equipment requirements and to characterize the system and its elements in terms of reliability and maintainability. The R&M model, an average value model, was developed for the AFHRL Digital Avionics Information System (DAIS) life cycle cost (LCC) study. It is patterned after LCOM and is compatible with LCOM input. The R&M model is used when the situation does not require a dynamic simulation. In the conceptual phase, one would expect extensive use of the R&M model. This emphasis would decrease and be redirected to use of LCOM as acquisition proceeds. The task analysis data and maintenance action network information from which these models operate are updated throughout acquisition.

The ISD/JGD decision process is initiated in the conceptual phase and continued during the validation to continually refine the training/technical manual requirement. This information, along with personnel data, is reflected in an early product - the personnel, training, and technical manual section of the integrated logistics support plan (ILSP). A single integrated task analysis on the actual system is initiated during full-scale development. This analysis is used to define both the training

Figure 2 INTEGRATED HUMAN RESOURCE TECHNOLOGY APPLICATION



and technical manual information content which subsequently forms the basis for the coordinated training program and technical manual development effort. A preliminary coordinated training program and technical manual set may be prepared during full-scale development. The training program and technical manuals are then finalized in the production phase.

SOC estimates are provided by the reliability, maintainability, and cost model (RMCM) during all phases of acquisition. This model utilizes the same input as the R&M model plus a cost data bank.

HRDT is incorporated in all acquisition phases. DODTs are prepared for critical system and support design trade-off issues. These trees are used to identify and document decision points where human resource, logistics, and cost data are required to aid in the decision process. The HRDT concept of providing information at critical decision points is implemented by the RMCM and/or LCOM supplemented by other techniques required to estimate training course length, technical manual requirements, and operations manpower. The iterative application of these estimating techniques allows an impact assessment to be made for each of the various design, maintenance, operations, and logistic support approaches under consideration. This assessment is made in terms of human resources, logistics, and system ownership cost. A review of each assessment to identify areas demanding unacceptable human resources, logistics requirements, or funding will assist in identifying additional critical system design and/or support planning issues for which tradeoffs must be considered.

All significant data required to support the five individual technologies are consolidated in a single data base, the CDB, under centralized control.

## 2.4 THE CHRT AND THE WEAPONS ACQUISITION PROCESS

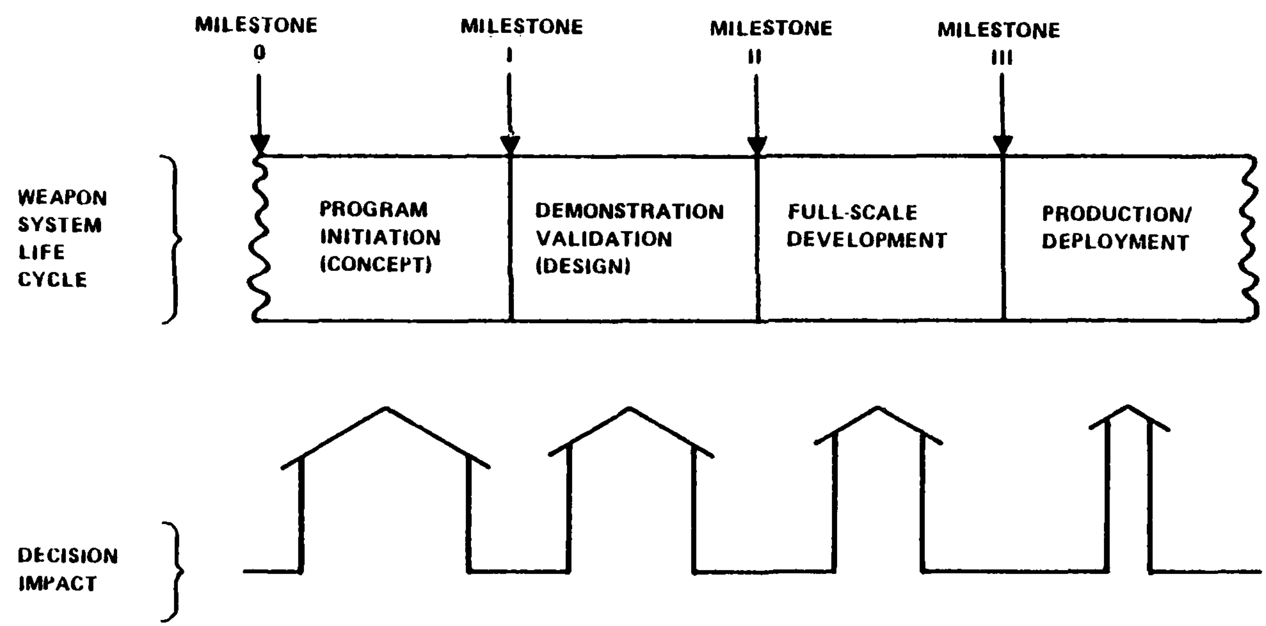
Simply stated, the impact of design and support planning decisions is greatest during the program initiation or concept phase when alternative solutions are being explored. These are the decisions that determine the basic system and support approach that will dominate all aspects of the total weapon system design. Unfortunately, at this phase of acquisition, detailed information to support these decisions is lacking. All too often, therefore, these early decisions are based on program direction, personal intuition, and/or previous experience which may or may not be compatible with the problem. Rarely are these decisions based on a rational assessment methodology that can be tracked, validated, and finally verified during deployment. Thus, no one can be held responsible for the results. The relative impact of system design and support planning decisions in acquisition is shown in Figure 3.

The same situation occurs on acquisition of major modifications and retrofits. Although the system itself may be in a single acquisition phase, the modification/retrofit must pass through all phases of concept, design, development, and production/deployment before it is complete. Again, it is in the concept phase that the basic system and support decisions are made. And again, they are rarely based on a rational methodology that can assess their effect.

On the other hand, if the operational system is to meet total performance expectations in the deployment phase, the system design and support plan requirements on which these expectations are based must be met. The hardware and software must meet performance standards. Adequate manpower with the desired skill levels must be provided. Training and technical manuals must be compatible with the personnel skills, the tasks to be performed, and the available support equipment. Often, the system design and support plan requirements are not met and, as a result, the expectations of early acquistiion are not achieved because the technique to translate expectation to reality is missing.

The CHRT provides a partial solution to these problems as it is both an assessment and a product development methodology. The assessment function extends analytical capabilitaies of the individual technologies into the early phases of acquisition where improved assessment as a base for evaluating alternatives is most needed. The product development function (a) extends the use of assessment data to the personnel, training, and technical manual section of the ILSP, (b) integrates manpower, personnel

Figure 3 RELATIVE IMPACT OF SYSTEM AND SUPPORT DESIGN DECISIONS DURING ACQUISITION



skills, and support equipment through a single task analysis as viable considerations in the determination of training and technical manual content, and (c) coordinates the previously independent development of the training program and technical manual set.

The CHRT emphasizes the assessment function during the early phases of acquisition, thus filling a need for a front-end impact analysis of system design and support plans. This assessment function is used to quantify the impact of system design and support plan decisions at various levels: weapon system, such as aircraft; major system, such as avionics; subsystem, such as inertial navigation set; or line replaceable unit (LRU), such as gyro. The assessment is made in terms of effects on human resources, logistics, and costs. The human resource and logistics factors assessed are manpower quantities, personnel skills and skill levels, training duration, technical manual content, support equipment quantity and type, reliability, and maintainability. The cost factors are the elements of LCC: system investment, support investment, and O&S costs. The CHRT is particularly sensitive to support investment and O&S costs. These two factors constitute SOC and describe the nonrecurring and recurring cost impact of the support design.

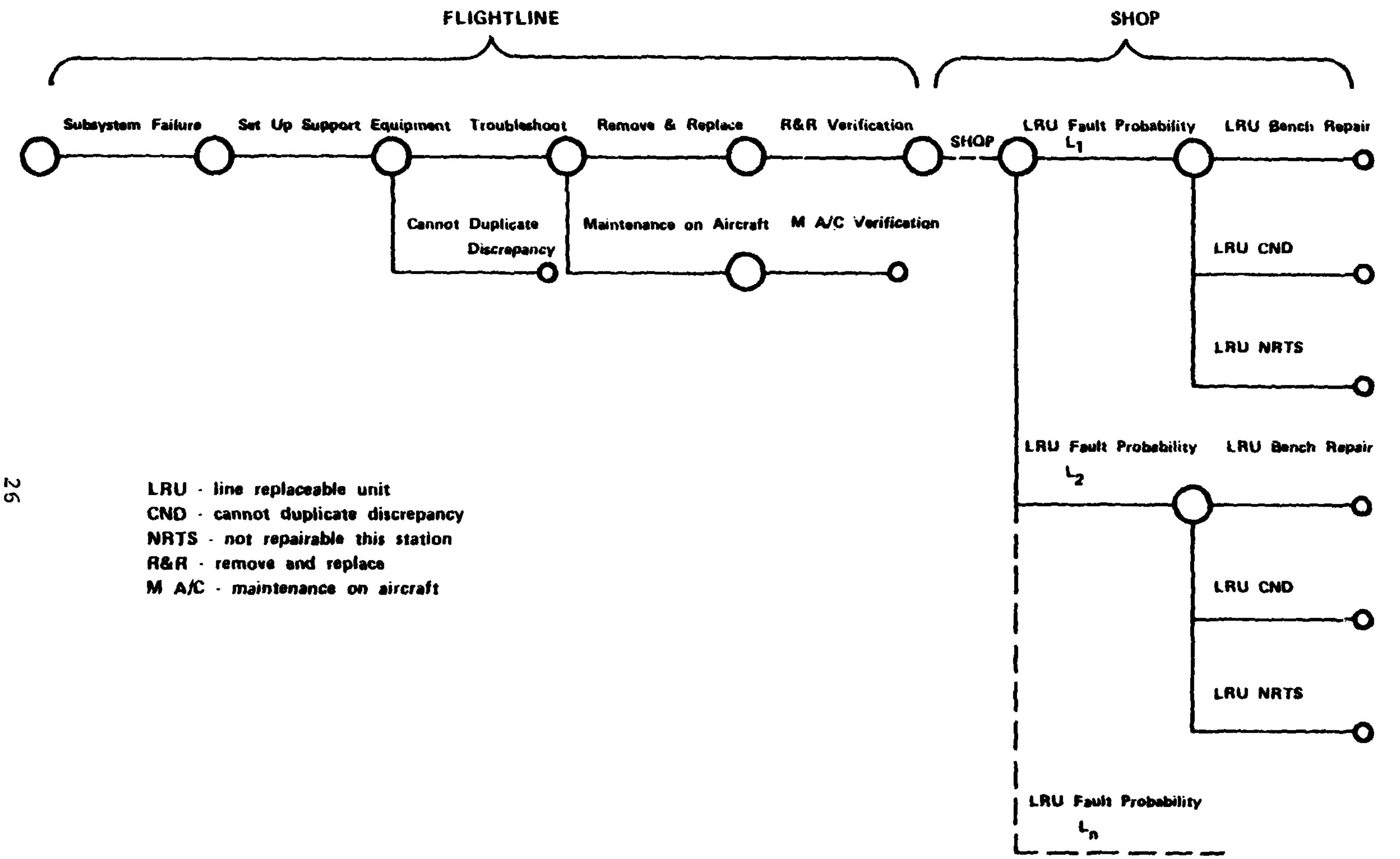
The product development fucntion is emphasized during the development and production/deployment phases of acquisition. Although this function is primarily oriented to the mainteannce area, it also may be used to address operations. The product development function uses assessment data in the early stages of acquisition to define a coordinated training and technical manual program which will support a specific system design and support plan. During the development and production/deployment phases, the coordinated training program and technical manual set are prepared.

## 2.5 THE MAINTENANCE ACTION NETWORK CONCEPT

The maintenance action network concept, a key feature of MMM, is also a key feature in the integration of the five technologies and the application of CHRT as an assessment methodology. A brief description of the maintenance action network as a means of modeling the maintenance system is provided here to provide the reader with a basic understanding of the concept.

A maintenance action network is depicted in Figure 4. This network represents the possible unscheduled maintenance actions which may occur within a subsystem of an aircraft major system.

Figure 4 GENERALIZED MAINTENANCE ACTION NETWORK




LRU - line replaceable unit
CND - cannot duplicate discrepancy
NRTS - not repairable this station
R&R - remove and replace
M A/C - maintenance on aircraft

An example would be the radar subsystem of the avionics system. Maintenance actions are performed at either the organizational (flightline) or the intermediate (shop) level. Depot level maintenance is not depicted. With minor modifications, this format also may be used to represent scheduled maintenance.

Each node in the network representation indicates the beginning and/or end of a specific event such as subsystem failure, set-up, support equipment, or troubleshooting. With the exception of subsystem failure, each event is annotated to indicate (a) the probability that the event will occur, (b) the time required to complete the event, (c) the maintenance personnel characteristics (skills, levels, and quantity) required to support the event, and (d) the support equipment (type and quantity) required to support the event. Subsystem failure is annotated only with the probability of occurrence.

The data used to annotate these networks in the early acquisition phases are developed from an analysis of historical data on comparable equipment. This analysis is partially judgmental and must consider the source of the historical data and the intended application of the proposed system. Historical data are gradually replaced with actual subsystem data as the subsystem hardware is built and use data are collected. The networks, therefore, grow from an estimated to an actual model of the maintenance system.

The manpower and support equipment resources required to support the maintenance system are then determined using either a summing technique to determine average value or by simulation to determine the dynamic response to a unique operational scenario. These techniques are supplemented with other techniques to estimate training, technical data, operation manpower, and cost to provide a complete human resources and life cycle cost estimate. This will be explained in later sections of this report.

# III. OVERVIEW OF THE CHRT AND THE CDB

This section provides an overview of the CHRT methodology and the CDB. The remaining sections of this report provide in-depth discussions of the CHRT and the CDB.

## 3.1 GENERAL

The CHRT and the CDB are depicted in Figure 18[3]. In this figure, CHRT activities are represented by blocks A to F as follows.

A. Program Definition, Comparability, and Task Analysis

B. Cost Data Bank Preparation

C. Logistic Resource Assessment

D. Life Cyle Cost Assessment

E. Impact Assessment

F. Product Development

Input and output data of each activity are represented by ellipses 1 to 17. The major data outputs and products of the total processes are represented by hexagons 01 to 03.

01. Baseline Assessments

02. Alternative Assessments

03. Coordinated Training and Technical Manual Products

---

3 Figure 18 is a fold-out located at the end of this report. It may be extended at this time and referred to while reading this section.

The total process is the CHRT. All data, with the exception of external data sources (ellipse 1), make up the CDB required to support the process.

## 3.2 CHRT APPLICATION

Before proceeding with a more detailed account of the activities and data which comprise the CHRT and the CDB, it is important to understand the basic concept and options represented by Figure 18.

As an assessment methodology, the CHRT is basically an information feedback process whereby a weapon system design and support plan with alternatives are described and assessed by the various CHRT activities. These assessments (hexagons 01 and 02) are in terms of human resources, logistics, and cost factors and are specific outputs of the impact assessment activity (block E). The assessments are used by management in further defining the weapon system. This feedback process is applicable throughout all phases of acquisition and is designed for iterative application at several levels of equipment detail (that is, weapon system, major system, subsystem, or LRU).

As a product development methodology, the CHRT uses the information developed by the CHRT activities to develop coordinated training and technical manual products (hexagon 03). These products range from the personnel, training, and technical manual section of the ILSP in early acquisition to the actual training plan and technical manuals produced in the full-scale development and/or production phase.

The CHRT is relevant and cost-effective throughout acquisition for three reasons. One, it can draw on both historical and current data sources. Two, it operates from a single evolving data base. Three, there is an inherent flow option in the process which changes methodology emphasis from assessment to product development as acquisition proceeds.

An inspection of the flow diagram (Figure 18) reveals a dual routing to the product development activity (block F). This activity may draw on either the data output of the logistic resource assessment activity (block C) which is represented by ellipses 9 through 15, or the intermediate products (ellipse 16) output of the program definition, comparability, and task analysis activity (block A). This option in flow reflects a transition in the CHRT orientation.

During the concept, design, and early development phases, the CHRT is primarily an assessment methodology. The assessments, represented by ellipses 9 through 15, are used to define and develop the personnel, training, and technical manual plans and programs. During the mid-development phase, however, the CHRT emphasis is on product development. The major inputs to the product development activity at this time are the intermediate products which are the result of an integrated task analysis performed on equipment. These intermediate products form the basis for the coordinated training program and technical manual set.

It is very important to note, however, that the CHRT always retains both assessment and product development functions. It is the emphasis on the functions that changes. The assessment and product development functions are complementary and may be applied in whole or in part during either system acquisition or modification/retrofit.

## 3.3 THE CONSOLIDATED DATA BASE (CDB)

The CHRT is supported by a CDB prepared for the weapon system under consideration. The data base contains, at a single location, all data required to achieve the aims of each of the five technologies. The data groups ahd files (subgroups) composing the CDB are listed in Table 1. The data groups are identified in Figure 18 as ellipses 2 through 17. (Note that ellipse 1, external data sources, is not part of the CDB and is discussed in Section 3.4.)

Table 1 CONSOLIDATED DATA BASE COMPOSITION

**PROGRAM REQUIREMENTS**

Key Event & Operational Readiness Schedule
Detailed-Phased Schedule

**SYSTEM DESIGN**

Hardware Configuration/ Characteristics
Software Configuration/ Characteristics

**SUPPORT PLAN**

Baseline(s)

**ESTIMATES**

Alternatives

**MAINTENANCE REQUIREMENTS AND TASKS**

Maintenance Activity Network Data
R&M Model Data
Maintenance Training Course Data

**OPERATIONS REQUIREMENTS AND TASKS**

Operations Crew and Aircraft Use Data
Operations Schedule
Operator Tasks
Operator Course Material Data

**ALTERNATIVES**

System/Subsystem Design Option Decision Trees
Support Design Option Decision Tree
Alternative Listing

**COST/COST RELATED DATA**

Baseline(s)
Alternatives

**EXPVAL OUTPUT**

Baseline(s)
Alternatives

**R&M OUTLINE**

Baseline(s)
Alternatives

**OPERATIONS AND SUPPORT**

Operations Manpower Estimates
- Baseline(s)
- Alternatives

Support Maintenance Manpower Estimates
- Baseline(s)
- Alternatives

**TRAINING ESTIMATES**

Maintenance Training Estimates
- Baseline(s)
- Alternatives

Operator Training Estimates
- Baseline(s)
- Alternatives

**TECHNICAL MANUAL ESTIMATES**

Baseline(s)
Alternatives

**TRAINING/AIDING MATRIX**

Baseline(s)
Alternatives

Table 1 CONSOLIDATED DATA BASE COMPOSITION (concluded)

<u>INTERMEDIATE</u>

Preliminary Task Identification Matrix (PTIM)
User Description
Technical Manual/Training Trade-Off Ground Rules
Task Analysis Work Sheets
Annotated Task Identification Matrix (ATIM)
Level-of-Detail Guide
Test Equipment and Tool Use Forms (TETUF)

<u>LIFE CYCLE COST ESTIMATES</u>

Baseline(s)
Alternatives

<u>BASELINE ASSESSMENTS</u>

Baseline 1
Baseline N

<u>ALTERNATIVE ASSESSMENTS</u>

Baseline 1
Baseline N

<u>COORDINATED TRAINING/TECHNICAL MANUAL PRODUCTS</u>

Integrated Personnel, Training, and Technical Manual Data
Training Products
Technical Manual Products

Each CDB data group has been developed and structured for specific application within the CHRT. The CDB consists of both computerized data formatted for operation with a specific automated program and hard copy data used or developed as part of a manual operation. This hard copy, in some cases, may be the output of one or more of the automated programs.

Ideally, the CDB is established during the concept phase of acquisition. Initially, the CDB is dependent on external planning, historical, and estimated data. Information is selected from these external data sources and, where necessary, adjusted to characterize the weapon system under consideration. This adjustment is part of a technical procedure called comparability analysis. The initial activity - program definition, comparability, and task analysis (block A) - results in a preliminary description of the hardware/software design, proposed manpower, and the support plan, as well as the tasks that must be performed to operate and maintain the system.

As the system acquisition proceeds from design through development, the CDB is improved in accuracy and detail by replacing planning and historical information with information acquired on the actual system. This actual system information consists of design/performance data, hardware/software configuration, manning, support data, and the results of an integrated task analysis performed on system equipment.

## 3.4 EXTERNAL DATA SOURCES

External data sources (ellipse 1) contribute to the total CHRT process, but are not part of the CDB. This data group represents the baseline and supplementary data sources from which information pertinent to the weapon system under investigation and essential to the CHRT application is drawn. The information in this data group is required for the two initial CHRT activities:

1. Program Definition, Comparability, and Task Analysis (block A).

2. Cost Data Bank Preparation (block B).

These activities establish and maintain the portion of the CDB essential to complete the remaining activities.

The specific data sources used to secure information will vary with time and the particular weapon system program. It is the responsibility of the CHRT manager of any program to secure information from the most current and applicable data sources available. When application of the CHRT is delegated to a contractor, it is the responsibility of the CHRT manager to oversee the contractor's efforts and to assure that the contractor uses appropriate data sources.

External data sources may be described as either baseline or supplementary. A baseline data source applies to, and in some ways specifically defines or constrains, the new weapon system approved for further development. The baseline data sources are officially controlled and revised at a DSARC milestone or some functionally similar review.

The baseline data sources are shown in Table 2. This table identifies the baseline data sources (the cells within the table). The table relates data sources to type of data and stages of weapon system acquisition. The baseline data sources describe the baseline approach in each of these areas. Baseline data sources may or may not identify alternatives to the baseline approaches.

Supplementary data sources include all appropriate historical records and standards. Examples of supplementary data sources are AFM 66-1, Historical Maintenance Data; AFR 173-10, USAF Cost Planning Factors; technical data and manuals on similar equipment or software; higher headquarters directives; and contractor proposals. Supplementary data sources are not rigidly defined. This data category includes any information which would provide greater insight to the weapon system under construction.

During the concept and design phases of acquisition, external data sources (ellipse 1) are generally limited to historical records, standards, estimates, and preliminary designs and plans. During the development and production/deployment phases, more accurate data reflecting the actual equipment become available. These more accurate data consist of both detail design data and performance data on the actual system hardware and software. In addition, the standards (such as regulations and military specifications) continue to apply.

Table 2 BASELINE DATA SOURCES

| | TYPE OF DATA DATA SOURCES | | | | |
|---|---|---|---|---|---|
| Acquisition Stage | Program Requirements | System Design | Support Plans | Operations/ Maintenance | Cost Cost |
| Concept | Program Management Directive | Mission Element need Statement | Program Management Directive | Mission Element need Statement | Affordability Statement |
| Design | Program Management Plan | System Design Concept(s) | ILS Concept | Generalized Operational Requirement | DSARCI Estimate |
| Development | Program Management Plan | System Specification | ILS Plan | Operations Plan | DSARCII Estimate |
| Production/ Deployment | Program Management Plan | System/ Subsystem/ Segment Specification | ILS Program | Operations Employment Plan | DSARCIII Estimate |

## 3.5 DETAILED DESCRIPTION OF THE CHRT AND THE CDB

Detailed descriptions of the CHRT activities and the CDB data groups are provided in the following sections. These sections are organized to address first the specific CHRT activity. The descriptions will refer to data groups which can be related to Figure 18 and also to those which cannot. Table 1 lists the data file names as well as the associated data groups.

# IV. PROGRAM DEFINITION, COMPARABILITY, AND TASK ANALYSIS

## 4.1 OVERVIEW

The program definition, comparability, and task analysis (block A) is the data gathering/data development effort required to establish and maintain the front end of the CDB. Information appropriate to both the baseline weapon system and any alternatives under consideration is gathered during this activity. A review of the external data sources (ellipse 1) is made to establish the program requirements (ellipse 2), the system design (ellipse 3), and the support plans (ellipse 4) data groups. With these data groups established, work is then started on the alternatives (ellipse 7) data group. Few actual data are available for any weapon system in the early phases of acquisition; therefore, comparable, historical, and estimated data must be used to initiate these data groups, as well as the maintenance requirements/tasks (ellipse 5) and operations requirements/tasks (ellipse 6) data groups. As acquisition proceeds, the data files are gradually updated with actual system data as they become available. Initially, the best available design or performance data adjusted to represent field application is used. Finally, in full-scale development or production/deployment, an integrated task analysis is performed preferably on actual equipment. This analysis is used to update the maintenance and operators requirements/tasks data groups and also results in the intermediate products data group (ellipse 16).

## 4.2 PROGRAM DEFINITION, COMPARABILITY, AND TASK ANALYSIS ACTIVITY

The program definition, comparability, and task analysis activity (block A) is the data gathering/data development effort required to establish and maintain the front end of the CDB. The data groups that make up this portion of the CDB are program requirements (ellipse 2), system design (ellipse 3), support plans (ellipse 4), maintenance requirements and tasks (ellipse 5), operations requirements and tasks (ellipse 6), and alternatives (ellipse 7).

These data groups and their associated data files will be referenced in the following discussion. (They will not be discussed in detail, however, until Section 4.3.) To maintain orientation, the reader is encouraged to refer to Table 1 in Section 3.3 during the following discussion.

The methodology employed to accomplish the program defintion, comparability, and task analysis consists of several techniques. These include the program defintiion analysis, comparability analysis, and integrated task analysis.

### 4.2.1 Program Definition Analysis

The program defintion analysis is the initial CHRT effort that must be conducted to put the weapon system (and/or systems of special interest) into context for CHRT application. The specific goals of any CHRT application must be well defined before initiating this effort so that the resources and activity may be limited to achieving those goals.

Initially, a review of external data sources (ellipse 1) is made to establish the program requirements data group (ellipse 2) and the support plans data group (ellipse 4). Portions of several data groups are also established as data files. These are the maintenance activity data file, the operations and aircraft use data file, the operations schedule data file, and the alternative listing data file. Simultaneously, the system design data group (ellipse 3) is established with equipment configuration data, and the preliminary information required to prepare the DODTs is obtained. These latter two efforts initially require significant engineering support.

There is no specific methodology involved in the program definition analysis. It is the data research effort required to identify the characteristic data elements which define the weapon system program.

### 4.2.2 Comparability Analysis

Simply stated, a comparability analysis or study is the overall process used to develop data on newly proposed or designed weapon systems by selecting operational equipment similar to that of the proposed weapon system and by adjusting the resource data associated with operational equipment to reflect the unique characteristics of the proposed equipment. The comparability analysis includes the development of maintenance demand rates for the proposed equipment which, in turn, can be used to determine resource requirements (such as manpower, support equipment, and spares for the weapon system). It also includes a systematic procedure for finding operational equipment that is similar to the proposed equipment.

The comparability analysis is drawn from the MMM technology where it is applied to aircraft hardware. Within CHRT, however, the concept is extended to software, operations, and training.

The CHRT has integrated the LCOM simulation and the R&M model as tools to assess the maintenance manpower and support equipment required to support an operational weapon system. Both the LCOM and the R&M model require input data in the form of maintenance action networks (see Figure 4 in Section 2). These networks represent the maintenance system and reflect both the system design and the support plan. Early estimates of the maintenance task data, which these networks contain, must be based on Air Force experience with comparable subsystems and equipment on existing aircraft modified to reflect the new system and support design and the environment. The technique used to develop the maintenance task data is generally termed a comparability analysis or study. It is described in detail in References 1, 2, and 3.

A comparability analysis is initiated using the outline of the hardware/configuration/characteristics data file as a starting point. That data file is completed and the maintenance action network and/or the R&M model data files are developed. These latter two files model the hardware maintenance system.

The comparability concept is extended within the CHRT to address software, operator tasks, and training. The software configuration/characteristics data file is defined using comparable systems and functions to estimate configuration, sizing, and other characteristics. The operator tasks data file is initially developed as a list of new or reallocated tasks related to a comparable operational system. (For example, the AMST was related to the C-130.) Finally, the maintenance training and operator course material data files are established with comparable course data which are used in further analysis.

The increased dependency of aircraft systems (particularly avionics) on software necessitates a detailed assessment of software support requirements. This assessment includes not only the operational flight program, but also the supporting hardware and software. Efforts to develop improved techniques to address this area continue to be researched. Most of these efforts, however, use the comparability technique. In the development of the software configuration/characteristics data file, the basic architecture, programs, and functions required of a system are identified and then sized in terms of memory requirements. Comparable software systems or portions thereof are used as references in making these intial estimates. Additional estimates are made to scope changes anticipated due to programming errors and new/modified requirements. This information may then be used to assess resources such as facilities, manpower, and system ownership cost. Improvements are presently being made to the CHRT to address this issue in greater depth and with increased accuracy.

As used to develop operator task data, the comparability analysis technique has several steps. The first step in this development process is to identify in a preliminary task list new, eliminated, or reallocated operational tasks relative to a comparable system. This might be accomplished by a mock-up task analysis. The next step is to develop an expanded operator task list which integrates these changes in a comparable system task list. Samples of preliminary and expanded operator task lists are provided in the next section. Finally, the maintenance training and operator course material data files are established using comparable training course data for the required skills. Course and task data are used in resource assessment to estimate training requirements.

### 4.2.3 Integrated Task Analysis

The integrated task analysis is the systematic study of the requirements of the tasks which must be performed to operate and maintain the weapon system. The task analysis should result in a determination of training objectives and of the behaviors and tasks a technical manual must support. The task analysis should be accomplished on actual hardware and include hardware analysis, job performance observation, and interviews. The hardware analysis should be continually updated through analysis of systems documentation, actual hardware, and interviews with experts. Information on tasks involving the hardware should be acquired by actual job performance observation. The user always must be kept in mind.

There are essentially two levels of analysis: task identification and analyses of the identified tasks. Initially, tasks are identified as statements of man-machine interactions which are outgrowths of the function assignments of men and machines. As presented, they do not entail understanding of the underlying behavioral process. However, at some point, the analysis must be carried down to the behavioral level; that is, cue-response to develop personnel subsystem products. The integrated task analysis is normally accomplished during the mid to late development phase. Conceivably, this analysis might even be delayed until early production. This is not desirable, however, and usually would be dictated by scheduling or financial considerations.

The function of the integrated task analysis is to provide the foundation for the development of coordianted training and technical manual products. The integrated task analysis was originally directed at maintenance tasks and will be discussed here in that context. The approach, however, is also applicable with modifications to operations.

The integrated task analysis is described in detail in AFHRL-TR-73-43 (References 4, 5, and 6). There are, however, some variations as it is applied within CHRT: (a) the analysis is applied to maintenance and operations, (b) it is used as the baseline for both training and technical manual development, and (c) its intermediate products are tailored to implement the personnel, training, and technical manual approach reflected in the assessments. Additionally, the information gathered in the task analyses is used to appropriately update all data groups resulting from the program definition and task analysis activity.

The following paragraphs will discuss the task analysis procedure as refined, and will generally describe the data files of the intermediate products data group as they relate to the task analyses. These data files consist of the following:

1. Preliminary task identification matrix (PTIM).
2. User description.
3. Technical manual/training trade-off ground rules.
4. Task analysis work sheets.
5. Annotated task identification matrix (ATIM).
6. Level-of-detail guide.
7. Test equipment and tool use forms (TETUF).

These data files will be described in more detail in Section 4.3.

The first step in the analysis is accomplished in the form of the PTIM. In the area of maintenance, what the technician does is determined by, in most cases, and limited by the hardware on which the maintenance activity is performed. To identify the tasks, there must be a listing of the hardware components and their parts to the level at which the maintenance will be carried out. This listing is provided in the PTIM.

The next step in the analysis is a matter of preference. The AFHRL-TR-73-43 series describes a procedure that begins with a PTIM and then an ATIM followed by a series of other documents. While the procedure described has obvious merit, it must be tailored to the scope of the task. The task analyst should not be tyrannized by task analysis forms and procedures such that the work of filling out the forms exceeds the value of the information. Furthermore, the procedure must allow for iteration, which is important to task analysis development. At this point in time, however, a description of the intended user of the technical manuals and training program should be prepared and verified. Additionally, work on the technical manual/training trade-off ground rules should be initiated.

The task analysis worksheets are the second step and the key intermediate product. The initial base for these sheets is the PTIM which provides hardware definition. The task identification and description information presented on these worksheets is completed bit by bit as the analysis proceeds. The purposes of the worksheet file are as follows:

1. Identify and verify hardware elements and task steps.

2. Describe the cue and accompanying responses for each step.

3. Ascertain the sensory, motor, and cognitive demands on the technician.

4. Determine essentially how the technician knows what to do, how to do it, and what feedback is available to indicate that it is done correctly.

5. List tools and equipment used.

6. Evaluate safety hazards and environmental factors.

Enough detail should be acquired to identify the cues and responses required to accomplish the task. Detailing to this level requires an intensive examination of the equipment and tasks. Therefore, the completion of this information will occur during the interview and job observation activity. It is difficult to complete the several documents called for in AFHRL-TR-73-43 until this level of detail of task identification and description has been reached; otherwise, the information allocation to a training and/or technical manual would be arbitrary.

The task analysis should be performed on actual equipment. Unfortunately, it is often difficult to obtain equipment for task analysis particularly on new acquisition programs. Therefore, the task analysis worksheets should first be outlined using drawings and/or mockups. The actual task performance then should be video taped. The outline prepared the task analyst for real-time participation in the task analysis. The video taping procedure assures that a record of all task activity is retained and provides a ready reference for a followup interview and iteration of worksheet data.

The task analysis worksheets provide the space to identify the hardware elements and task steps, to describe the cue and response for each step, and to document the specific sensory, motor, or cognitive demands on the technician. They are also used to document other task information, direct the use of alternative tools, note safety hazards and environmental factors, and cover the tools and equipment required to perform the task. The worksheets allow documentation of objectives or functions that should receive special emphasis during training and/or in the technical manual. As the task analysis worksheets are completed, the test equipment and tool use forms (TETUFs) are also completed. The TETUFs document the functions of the test equipment or tools and identify the information to be allocated to technical manuals or training. This latter determination is made using the technical manual/training trade-off ground rules previously mentioned.

The detailed task data available from the completed worksheets and the completed technical manual/training trade-off ground rules facilitate the completion of the ATIM. The technical manual/training trade-off ground rules established for the desired personnel, training, and technical manual approach assure that appropriate allocations are made in task information coverage to training and the technical manual. The ATIM provides a matrix on which the technical manual/training allocation can be documented. The fact that a specific maintenance function is performed on a system hardware item is determined during the task analysis. This fact is also documented on the ATIM with an annotation which indicates where the allocation of information will be emphasized. The possible choices are training (H), technical manual (B), or both training and technical manual (J). The H, B, and J notations have traditionally represented "head", "book", and "joint", respectively.

The level-of-detail guide is established in parallel with the foregoing activity. The completed ATIM, level-of-detail guide, and TETUFs provide the final intermediate product package. The information provided in this intermediate product package may be supplemented as desired by the task analyst. Some suggestions are made in AFHRL-TR-73-43.

### 4.2.4 DODTs

DODTs comprise the system/subsystem design option decision tree and the support design option decsion tree data files. They provide a graphic format with which to display the various design options available at each decision point in the design process. The DODT facilitates early identification of design options to evaluate appropriate options for impact on human resources, logistics, and cost.

The technique for preparing DODTs is clearly explained in AFHRL-TR-75-9, Reference 7. DODTs are used in CHRT to depict the overall system and critical subsystems. The general system level is important because the trade-offs normally depicted have significant life cycle impact. These trade-offs might include such decisions as crew size, number of engines, and structural configuration. In addition, the general system tree is helpful in identifying critical subsystems.

Subsystem DODTs are expensive to develop and should be limited to critical subsystems. These critical subsystems become apparent as system and design concepts evolve. These subsystems press the state-of-the-art (such as STOL engine/wing configuration), are critical to all missions, have many operating elements, receive heavy use (such as landing gear), and have many inherent alternatives (such as avionics). The CHRT extended the DODT concept to the support design also. A basic logistic option tree was developed to document the baseline approach and to identify viable alternative logistics concepts.

## 4.3 DATA OUTPUT OF THE PROGRAM DEFINITION, COMPARABILITY, AND TASK ANALYSIS ACTIVITY

The data output of the program definition, comparability, and task analysis consists of the data groups and associated data files as follows. (Refer also to Figure 18.)

PROGRAM REQUIREMENTS

Key Event & Operational Detailed Phased Schedule

SYSTEM DESIGN

Hardware Configuration/Characteristics
Software Configuration/Characteristics

SUPPORT PLANS

Baseline(s)
Alternatives

MAINTENANCE REQUIREMENTS AND TASKS

Maintenance Activity Data
Maintenance Action Network Data
R&M Model Data
Maintenance Training Course Data

OPERATIONS REQUIREMENTS AND TASKS

Operations Crew and Aircraft Use Data
Operations Schedule
Operator Tasks
Operator Course Material Data

INTERMEDIATE PRODUCTS

PTIM
User Description
Technical Manual/Training Trade-off Ground Rules
Task Analysis Work Sheets
ATIM
Level-of-Detail Guide
TETUF

ALTERNATIVES

System/Subsystem Design Option Decision Trees
Support Design Option Decision Trees
Alternative Listing

Detailed descriptions of these data groups and files are provided in the subsections which follow.

#### 4.3.1 Program Requirements Data Group

The program requirements data group (ellipse 2) consists of two data files. These files are a key event and operational readiness schedule and a detailed phased schedule. Both contain the production and operational planning information necessary to perform resource and cost assessments (blocks C and D). The prime data source from which these schedules may be developed is the weapon system Program Management Plan (PMP). The program requirements data group is usually affected by system design and support planning alternatives unless the total character of the design or procurement approach is the alternative in question. One set of files, therefore, should be adequate.

##### 4.3.1.1 Key Event and Operational Readiness Schedule Data File

The key event and operational readiness schedule data file provides detailed program schedule information. It is maintained in the CDB as hard copy. The schedule indicates the following:

1. Dates for events such as delivery of aircraft (A/C) and initial operating capability (OIC).

2. Total number of training (Tng) and operational (Ops) squadrons (sq) available each year.

3. Squadron distribution in terms of the number of Continental United States (CONUS) or overseas (O/S) locations and the number of squadrons per location.

As the acquisition program progresses, other key events (such as DSARC reviews, contract training start, and technical manual validation and verification) would be added. The sources for this data file are the PMP and contractor schedules. This file is primarily a source for cost/cost-related data (ellipse 8). An example schedule is provided in Table 3.

##### 4.3.1.2 Detailed Phased Schedule Data File

The detailed phased schedule data file depicts the production schedule, operations phase-in and phase-out plan, and

Table 3 KEY EVENT AND OPERATIONAL READINESS SCHEDULE

| Date | Event | Tng Sq | Ops Sq | Conus Locations No. | Conus Locations Sq/Loc | O/S Locations No. | O/S Locations Sq/Loc |
|---|---|---|---|---|---|---|---|
| Oct 82 | Production Decision | 1 | -- | 1 | 1 | -- | -- |
| Oct 82 | First Delivery | 1 | -- | 1 | 1 | -- | -- |
| Oct 83 | 4 A/C | 1 | -- | -- | -- | -- | -- |
| May 84 | 10C | 1 | 1 | 1 | 2 | -- | -- |
| Oct 84 | 20 A/C | 1 | 1 | 1 | 2 | -- | -- |
| Oct 85 | 60 A/C | 1 | 3 | 2 | 2 | -- | -- |
| Oct 86 | 120 A/C | 1 | 7 | 3 | 2 | 1 | 2 |
| Oct 87 | 180 A/C | 1 | 10 | 3 | 3 | 1 | 2 |
| Oct 88 | 240 A/C | 1 | 14 | 3<br>1 | 3<br>1 | 2 | 2 |
| Oct 89<br>Oct 03 | 277 A/C | 1 | 16 | 4 | 3 | 2 | 2 |
| Oct 04 | 273 A/C | 1 | 16 | 4 | 3 | 2 | 2 |

expected use over the system life cycle. This data file is also retained in the CDB as a hard copy presentation. The primary sources for this schedule would be the PMP and the generalized operational requirement (GOR). The file is primarily a source for cost/cost-related data (ellipse 8) and for the preparation of baseline and alternative assessments (ellipses 01 and 02). An example schedule is shown in Table 4, enhanced to include operations manpower estimates in the crew column.

### 4.3.2 System Design Data Group

The system design data group (ellipse 3) describes the elements of the system design. It consists of two data files: the hardware configuration/characteristics data file and the software configuration/characteristics data file.

#### 4.3.2.1 Hardware Configuration/Characteristics Data File

The hardware configuration/characteristics data file details system equipment and is retained in the CDB as a Hollerith and card deck. A deck is prepared for each weapon system of interest (for example, AMST). Each deck contains a set of cards for each major system of interest within the weapon system (for example, landing gear). An individual card is prepared for each subsystem within the major system (such as wheels and tires) and for each LRU within the subsystem (such as nose landing gear tire). A card listing is also maintained for reference. A sample card listing is provided in Table 5, followed by a description of the card format and column content.

The hardware configuration/characteristics listing cards are formatted as follows:

| <u>Columns</u> | <u>Identifier</u> |
|---|---|
| 1-2 | Card type indicator (always CR).<br>This provides a cross-reference between the equipment name and identification number for the R&M model and RMCM. |
| 4-10 | Equipment identification (ID) number.<br>The ID defines the equipment in a series of codes showing the type of weapon system in column 4, the major system within the weapon system in column 5, |

Table 4 DETAILED – PHASED SCHEDULE

| Fiscal Year | Aircraft: Production UE | Production NOA | Avg. No. Available UE | Avg. No. Available NOA(*) | Total End Year UE | Total End Year NOA(*) | Flytime/year UE | Flytime/year NOA** | Crew†: Training OPS | Training Inst. | Total End Year OPS | Total End Year Inst. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FY83 | 0 | 4 | 0 | 2(2) | 0 | 4(4) | | 936 | 0 | 8 | 0 | 8 |
| FY84 | 12 | 4 | 6 | 6(6) | 12 | 8(8) | 2808 | | 24 | 8 | 24 | 16 |
| FY85 | 36 | 4 | 30 | 10(10) | 48 | 12(12) | 14040 | 4680 | 776 | 8 | 96 | 24 |
| FY86 | 56 | 4 | 76 | 14(14) | 104 | 16(16) | 35568 | 6552 | 124 | 8 | 208 | 32 |
| FY87 | 56 | 4 | 132 | 18(16) | 160 | 20(16) | 61776 | 7488 | 136 | 0 | 320 | 32 |
| FY88 | 60 | 0 | 190 | 20(16) | 220 | 20(16) | 88920 | 7488 | 155 | 0 | 440 | 32 |
| FY89 | 36 | 1 | 238 | 20(16) | 256 | 21(16) | 111384 | 7488 | 119 | 0 | 512 | 32 |
| FY90-02 | 0 | 0 | 256 | 21(16) | 256 | 21(16) | 119808 | 7488 | 54 | 0 | 512 | 32 |
| FY03 | | -4 | 256 | 19(15) | 256 | 17(14) | 119808 | 7020 | 54 | 0 | 512 | 28 |
| FY04 | -16 | -0 | 248 | 17(14) | 240 | 17(14) | 116064 | 6552 | 54 | 0 | 480 | 28 |
| FY05 | -32 | -8 | 232 | 13(11) | 208 | 9(8) | 108576 | 4680 | 0 | 0 | 416 | 16 |
| FY06 | -56 | -4 | 180 | 7(6) | 152 | 5(4) | 84240 | 2808 | 0 | 0 | 304 | 8 |
| FY07 | -56 | -4 | 124 | 3(0) | 96 | 1(0) | 58032 | 0 | 0 | 0 | 192 | 0 |
| FY08 | -60 | -0 | 66 | 1(0) | 36 | 1(0) | 30888 | 0 | 0 | 0 | 72 | 0 |
| FY09 | -36 | -1 | 18 | 0(0) | 0 | 0(0) | 16848 | 0 | 0 | 0 | 0 | 0 |

LEGEND

UE – unit equipped

NOA – not operationally available

OPS – operational crews

INST – instructor crews

NOTES

* – NOA A/C used for training

** – time reflects 1.8 hr./day for training aircraft

† – crew requirements based on 2 crews/aircraft

Table 5

HARDWARE CONFIGURATION/CHARACTERISTICS LISTING
PROJECTED AMST LANDING GEAR

| | | | | | | |
|---|---|---|---|---|---|---|
| CR GLG110 -1 | | 13A00 | 2 | MAIN LANDING GEAR | C141 | 4 |
| CR GLG111 -1 | 2938.6 | 13AA0 | 2 | MECHANICAL PARTS (MLG) | | 32 |
| CR GLG112 -1 | 494.0 | 13AB0 | 2 | HYDRAULIC PARTS (MLG) | | 19 |
| CR GLG113 -1 | 10.0 | 13AC0 | 2 | ELECTRICAL PARTS (MLG) | | 8 |
| CR GLG114 -1 | 1.0 | 13AD0 | 2 | MLG INSTRUMENTS | | 2 |
| CR GLG120 -1 | | 13B00 | 1 | NOSE LANDING GEAR | C141 | 3 |
| CR GLG121 -1 | 962.6 | 13BA0 | 1 | MECHANICAL PARTS (NLG) | | 20 |
| CR GLG122 -1 | 247.0 | 13BB0 | 1 | HYDRAULIC PARTS (NLG) | | 10 |
| CR GLG123 -1 | 5.0 | 13BC0 | 1 | ELECTRICAL PARTS (NLG) | | 4 |
| CR GLG130 -1 | | 13C00 | 1 | LANDING GEAR CONTROLS | C141 | 1 |
| CR GLG131 -1 | 280.0 | 13CA0 | 1 | ELECTRICAL PARTS (LGC) | | 11 |
| CR GLG140 -1 | | 13D00 | 1 | BRAKES/ANTI-SKID | C141 | 3 |
| CR GLG141 -1 | 478.7 | 13DB0 | 1 | HYDRAULIC PARTS (BRAKES) | | 13 |
| CR GLG142 -1 | 193.0 | 13DC0 | 1 | ELECTRICAL PARTS (BRAKES) | | 8 |
| CR GLG143 -1 | 115.0 | 13DA0 | 1 | MECHANICAL PARTS (BRAKES) | | 10 |
| CR GLG150 -1 | | 13E00 | 1 | STEERING SYSTEM | C141 | 2 |
| CR GLG151 -1 | 183.0 | 13EB0 | 1 | HYDRAULIC PARTS (STEERING) | | 8 |
| CR GLG152 -1 | 50.0 | 13EA0 | 1 | MECHANICAL PARTS (STEERING) | | 11 |
| CR GLG160 -1 | | 13F00 | 1 | EMERGENCY SYSTEMS | C141 | 2 |
| CR GLG161 -1 | 40.0 | 13FA0 | 1 | MLG EMERGENCY RELEASE SYSTEM | | 14 |
| CR GLG162 -1 | 2.0 | 13FB0 | 1 | NLG EMERGENCY MANUAL RELEASE SYSTEM | | 1 |
| CR GLG170 -1 | | 13G00 | 1 | WHEELS AND TIRES | C141 | 6 |
| CR GLG171 -1 | 61.1 | 13GA0 | 8 | MLG WHEEL (W&T) | | 3 |
| CR GLG172 -1 | 19.9 | 13FB0 | 8 | MLG TIRE-SMOOTH (W&T) | | 4 |
| CR GLG173 -1 | 129.9 | 13GD0 | 2 | NLG WHEEL (W&T) | | 3 |
| CR GLG174 -1 | 19.9 | 13GE0 | 2 | NLG TIRE (W&T) | | 3 |
| CR GLG175 -1 | 2.0 | 13GAB | 8 | MLG WHEEL BEARING | | 1 |
| CR GLG176 -1 | 1.0 | 13GBB | 2 | NLG WHEEL BEARING | | 1 |

functional grouping of the major system in column 6, and a numerical breakdown by operational function (such as radar navigation, radio navigation, or bombing navigation), subsystem, line replaceable unit (LRU), and shop replaceable unit (SRU) in columns 7 to 10. These codes are determined by the user since they are configuration-dependent.

11-12 Card sequence (always 1).

14-18 Work unit code (WUC).
The WUC is used to identify each subsystem and LRU in the aircraft system.

26-27 The quantity per aircraft (QPA) of a particular subsystem or LRU in the aircraft system.

29-67 Equipment name or description of the operational function assigned to a subsystem or LRU. (Right-justify comparable system identification, if applicable.)

75-76 The number of LRUs in the subsystem for which input data have been provided, and the number of SRUs per LRU on LRU input cards. Input data are provided for those LRUs requiring a significant amount of unscheduled maintenance.

The hardware configuration/characteristics data file is directly affected by hardware alternatives. The R&M data file (if used) and the maintenance action netawork data file are also sensitive to other alternatives. A separate group of cards must be developed to cover each alternative. The mechanics are covered under resource assessment (block C) in Section 9. The data in these files are obtained through the comparability analysis during early acquisition. These data are then gradually updated to reflect actual equipment as actual data (such as specifications and drawings) become available.

The hardware configuration/characteristics data file is used both as an equipment listing and also as the cross-reference file input to the resource assessment program which translates the simplified LCOM Extended Form 11 data file to an R&M data file. This automatic transformation allows the R&M model to be driven by simplified LCOM Extended Form 11 data. It eliminates the need to retain both an R&M data file and an LCOM Extended Form 11 data file in the CDB.

4.3.2.2 Software Configuration/Characteristics Data File

The software configuration/characteristics data file lists software functions to be performed and computer memory requirements. It is retained in the CDB as a hard copy list. The source of these data would be the engineering activity responsible for system development. The data are used to assess software requirements and costs.

A sample of a computer memory requirements table is shown in Table 6. This table was prepared during the early AMST prototype phase by the Air Force Avionics Laboratory. A separate software configuration/characteristics data file is maintained on each major system for which software is required.

Table 6 PROJECTED AMST COMPUTER MEMORY REQUIREMENTS

| SOFTWARE FUNCTIONS | MEMORY (16 BIT WORDS)* |
|---|---|
| Input Control Processing | 0.5K |
| Computed Air Release Point | 2.0K |
| Navigation Filter | 1.5K |
| FCS Format Output | 0.2K |
| Output Display Data | 2.0K |
| CDR Interface | 0.1K |
| On-Board Test | 0.1K |
| Computer Self-Test | 0.6K |
| Executive/MUX Control | 2.0K |
| Utility Routines/Constants | 1.5K |
| Weight/Balance/C.G. | 0.5K |
| Optimum Cruise | 0.5K |

*K indicates thousands

The data in the software configuration/characteristics data file are used as an input to both resource assessment (block C) and cost data bank preparation (block B). It is also expected to be the baseline from which software maintenance tasks are identified. The reader can expect significant revision to and expansion of these data.

### 4.3.3 Support Plans Data Group

The support plans data group (ellipse 4) consists of a series of basic, but significant statements describing the ILS elements and reflecting the latest ILS decisions. The number of data files within this data group vary with the number of logistic support approaches being assessed. Each support plan data file is used to summarize the ILS concept, plan, or program. These files are also used as a guide in the development of the maintenance action networks since these networks must reflect the planned method of maintenance support as well as the appropriate maintenance actions. A support plan data file developed for the AMST is shown in Table 7.

For a total weapon system where CHRT is being applied to many major systems or subsystems, the type of data file shown in Table 7 may be too general. This is because it does not discriminate variations in the support plan required to accommodate unique system characteristics. In such cases, a support plan data file is needed for each system. For example, separate support plan data files may be desirable for engines and avionics.

Table 7 AMST SUPPORT PLAN DATA FILE

| ILS ELEMENT | STATEMENT |
|---|---|
| Maintainability and Reliability Interface | MMH/FA - 19<br>MTTR/FL - 0.5<br>Operational Availability - .85 |
| Maintenance Plan | 3 Level Organic Maintenance |
| Support & Test Equipment | Combination of Support Equipment, Automatic Test Equipment, and Built-In Test Equipment |
| Supply Support | Single Depot for 4 CONUS, 2 O/S Bases |
| Transportation & Handling | |
| Technical Data | Task-Oriented Technical Manuals |
| Facilities | Single Software Support Facility |
| Personnel & Training | Standard Personnel Levels<br>Specialty Training - Conventional<br>Technical Training - Conventional<br>Field Training Detachment (FTD) |
| System Ownership Cost Objective | Design-to-LCC |

### 4.3.4 Maintenance Requirements and Tasks Data Group

The maintenance requirements and tasks group (ellipse 5) provides direct input data to the cost data bank preparation (block B) and logistic resource assessment (block C) activities. This data group consists of four data files: (a) maintenance activity, (b) maintenance action network, (c) R&M model, and (d) maintenance training course data files.

#### 4.3.4.1 Maintenance Activity Data File

The maintenance activity data file is a hard copy statement of expected maintenance coverage and maintenance manpower efficiency by Air Force specialty code (AFSC) and skill level. A five-day per week, eight-hour shift, and a .6 efficiency factor were used to express peacetime maintenance activity for the AMST on the CHRT demonstration. This description was applied to all AFSCs. A six-day per week, 12-hour shift, and .8 efficiency factor was assumed for a wartime maintenance activity. (The efficiency factors are normally found in operations or ILS documents.) The expected maintenance coverage and maintenance manpower efficiency data are required to convert maintenance man-hours per flying hour (MMH/FH) to quantify personnel. The failure drivers (e.g., sorties, rounds of ammunition, flying hours) must be indicated by the user. For the R&M model, these are stated in terms of their relationship to flying hours for the period being computed. MMH per time period is a standard output of three resource assessment techniques: (a) the LCOM simulation, (b) the expected value model, and (c) the R&M model.

#### 4.3.4.2 Maintenance Action Network Data File (Extended Form 11 File)

The maintenance action network data file reflects the maintenance system for a specific hardware configuration. This file is the master maintenance system file and the major input to both LCOM and the R&M model. It is the most significant data file in the CDB and requires the most resources to develop and maintain. It is also the most sensitive file because almost any system and/or support change will require a modification to the maintenance action networks. A detailed description of these networks, their development, maintenance, and use was provided in Section 2.5. Discussion here is limited to content and format.

The maintenance action network data file consists of a card deck developed in the Extended Form 11 format. The Extended Form 11 was developed at AFHRL to compress onto one form the task network information of the LCOM Form 11, the task resource requirements of LCOM Form 12, the reosurce definitions of LCOM Form 13, the failure clock decrements of LCOM Form 14, and the report headings of LCOM Form 10. See References 26 and 27 for more information on preprocessors of the Extended Form 11 which prepare the LCOM forms. The Extended Form 11 is completely compatible with the preprocessors for the LCOM simulation and partially compatible with a preprocessor for the R&M model. The degree of this compatibility with the R&M model is directly proportional to the complexity of the network.

Because of its importance to CHRT and the CDB, a workable description of the data elements and the specific format for each field of these 80-column records follows. (The coding of maintenance acton networks in the Extended Form 11 format is described in Reference 2.)

The card layout form for these records is shown in Figure 5 and a codes and symbols dictionary is provided in Table 8. The dictionary may be referenced by column number of the field or by the name of the field. The field format of the data elements is provided in Table 9 and the appropriate clarifying definitions are provided in Table 10.

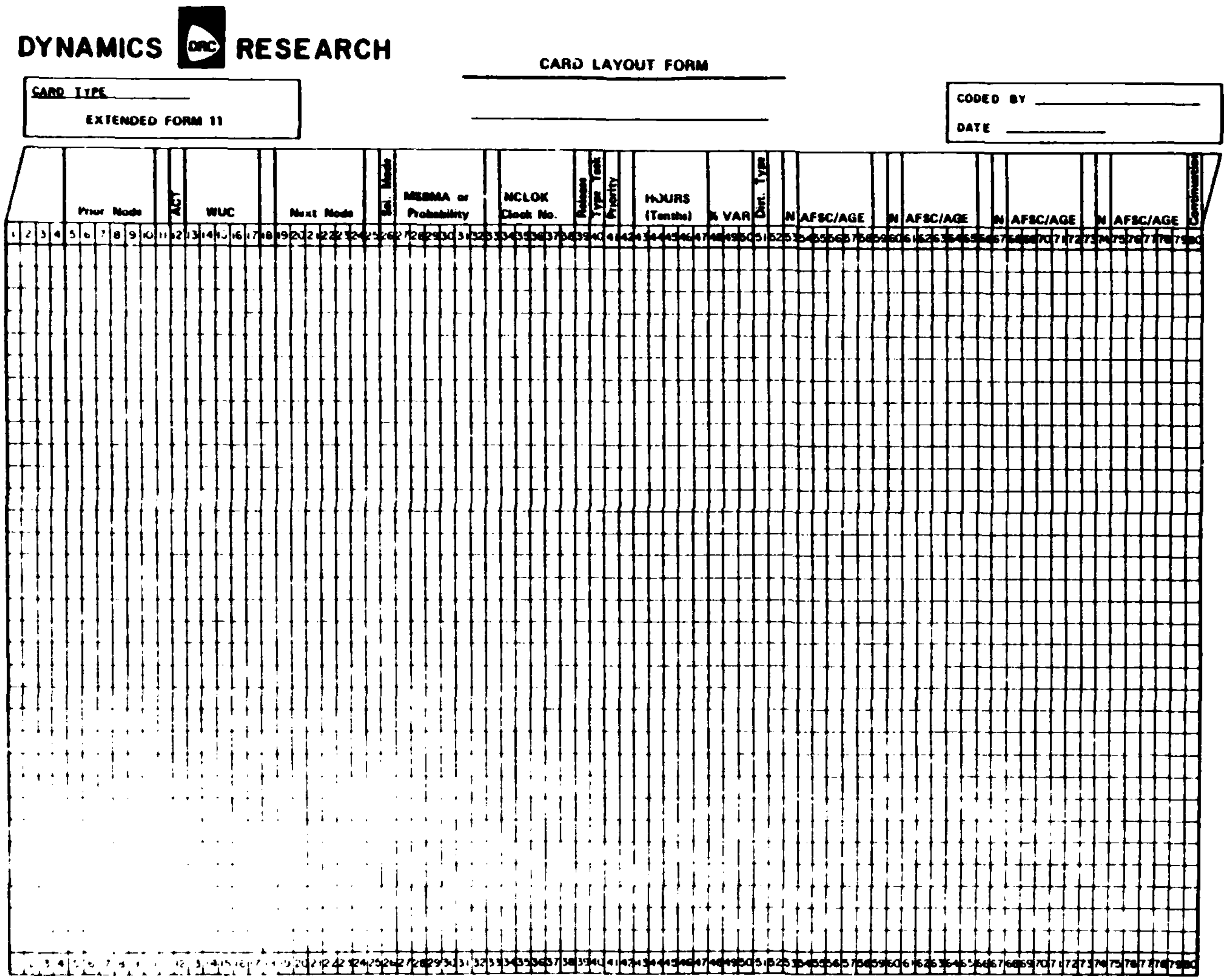



Figure 5 CARD LAYOUT FORM

## Table 8 CODES AND SYMBOLS DICTIONARY

CODES AND SYMBOLS

DICTIONARY FOR DATA ELEMENTS AND DATA ITEMS

ACTION CODES: (Column 12)

- A – Obtain and set up support equipment
- C – Call section (reference to a sub-network)
- F – Failure clock. Controls the frequency at which the network will be accessed regardless of whether a failure has actually occurred.
- G – Generate repair or replace unit
- H – Inspections, service, scheduled checks
- K – In-shop bench check of LRU finds it serviceable
- L – Dummy task for probabilistic determination of which LRU was removed from a failed subsystem
- M – On-aircraft repair not involving LRU removal
- N – In-shop bench check of LRU finds it broken, determines repair cannot be made at base level, prepares for shipment, and orders replacement from depot, i.e., NRTS.
- P – Dummy task representing time to obtain replacement LRU from depot
- Q – Draw LRU from base level stock, consume resources
- R – On-aircraft remove and replace of an LRU
- S – Dummy task representing shop entry point
- T – On-aircraft troubleshoot
- V – Inspect or functional check to verify on-aircraft repair
- W – In-shop bench check and repair of LRU
- X – On-aircraft gain access to subsystem and/or LRU

SELECTION MODES: (Column 26)

- C – Do all required tasks in the defined call section.
- D – Do the task.
- E – Do the task when indicated by a random draw against the specified mutually exclusive probability.
- F – Do the task only when the clock has indicated a failure.
- G – Do the task when indicated by a random draw against the specified non-mutually exclusive probability with such draws repeated until at least one task in the set has been selected.

TYPE TASK CODES: (Column 40)

- 1 – Sortie
- 2 – Unscheduled maintenance
- 3 – Scheduled maintenance
- 4 – Depot repair
- 5 – Other

DISTRIBUTION TYPE (Column 51)

- L = Lognormal
- N = Normal
- C = Constant (variability left blank)

Table 9 FIELD FORMAT OF DATA ELEMENTS

| Data Elements | | Field Format | | | |
|---|---|---|---|---|---|
| Column | Title | Length | Type | Justification | Decimal Placement |
| 5-10 | PRIOR NODE | 6 | X | R* | – |
| 11 | BLANK | 1 | – | | |
| 12 | ACTION CODE | 1 | X | F | – |
| 13-17 | WUC | 5 | X | F | – |
| 18 | BLANK | 1 | – | | |
| 19-24 | NEXT NODE | 6 | X | R* | – |
| 25 | BLANK, EXCEPT HEADER | 1 | A | F | – |
| 26 | SELECTION MODE | 1 | A | F | – |
| 27-32 | MSBMA OR PROBABILITY (E,G) | | | R | (2,5) |
| 33 | BLANK | 1 | – | | |
| 34-38 | CLOCK NUMBER | 5 | X | F | – |
| 39 | RELEASE | 1 | X | F | – |
| 40 | TYPE TASK | 1 | N | F | – |
| 41 | PRIORITY | 1 | N | F | – |
| 42 | BLANK | 1 | – | | |
| 43-47 | HOURS | 5 | N | R | 1 |
| 48-50 | % VARIANCE | 3 | N | F | 0 |
| 51 | DISTRIBUTION TYPE | 1 | A | F | – |
| 52 | BLANK | 1 | – | | |
| 53 | NUMBER | 1 | N | F | 0 |
| 54-58 | AFSC/AGE | 5 | X | L | - |
| 59 | BLANK | 1 | – | | |
| 60 | NUMBER | 1 | N | F | 0 |
| 61-65 | AFSC/AGE | 5 | X | L | – |
| 66 | BLANK | 1 | – | | |
| 67 | NUMBER | 1 | N | F | 0 |
| 68-72 | AFSC/AGE | 5 | X | L | – |
| 73 | BLANK | 1 | – | | |
| 74 | NUMBER | 1 | N | F | 0 |
| 75-79 | AFSC/AGE | 5 | X | L | – |
| 80 | CONTINUATION | 1 | A | F | – |

*These fields have been coded right-justified, but the LCOM program will automatically left-justify them.

## Table 10 DEFINITION FOR FIELD FORMAT OF DATA ELEMENTS

**DATA ELEMENT**
A basic unit of information that has a unique meaning that may have subcategories of distinct units or values (data items).

**DATA ELEMENT DEFINITION**
A narrative defintiion of the data element in sufficient detail to present a clear and complete understanding of the precise data or element of information that the data element presents.

**DATA ITEM**
A subcategory of descriptive information, distinct units, or values classified under a data element.

**DATA CODE**
A number, letter, character, symbol, or any combination thereof used to represent either a data item, or a data element having no data item subcategories.

**FIELD FORMAT**
A specification for the length, type, justification, and decimal placement of a data element or data item thereof.

**LENGTH**
The number of character positions in the data element. When the length is variable, a maximum is specified.

**TYPE**
A specification of the character type, where "A" specifies that all characters of the data element are alphabetic; "N" specifies that all characters of the data element are numeric; and, "X" specifies that the characters of the data element may be alpha or numeric, and may contain special characters.

**JUSTIFICATION**
Specifies from which side of the field the characters of the data element are entered. Those starting at the left are left-justified (L); those at the right are right-justified (R); and, those which always occupy the entire field are fixed (F).

**DECIMAL PLACEMENT**
Specifies the number of character positions to the right of the assumed decimal point when the data element is numeric in all character positions. A dash will be used if this column is not applicable.

A description of data elements for the header card records and task records is provided as follows.

HEADER CARD RECORDS

| Column(s) | Data Element | Definition |
|---|---|---|
| 25 | | H indicates the record is a header card. |
| 34-38 | Clock Number | The work unit code (WUC) of the subsystem. The same clock number is entered on every task record in the network that follows the F tasks. |
| 42-73 | | Equipment title and/or description of the subsystem LRU of the network that follows. |
| 75-78 | Classification Identifier | A code to identify the mission and system, or functional portion of a system of which the subsystem is a part. (See Table 8, CODES AND SYMBOLS.) |

TASK RECORDS

| Column(s) | Data Element | Definition |
|---|---|---|
| 5-10 | Prior Node | The starting node number for each task. |
| 12 | Action | A code identifying the type of activity occurring in the task. The action code with the WUC entry in the next field constitutes the task code. (See Table 8, CODES AND SYMBOLS.) |

| | | |
|---|---|---|
| 13-17 | WUC | The work unit code assigned to the subsystem or LRU being maintained. Columns 12-17 are the task code for the action/event taking place for that particular record. (See Table 8, CODES AND SYMBOLS.) |
| 19-24 | Next Node | Follows the Task Code and is used as the starting node for the next task. The next node is left blank when no more tasks follow. |
| 26 | Selection Mode | A code that specifies the network task processing logic. An appropriate Mean Sorties Between Maintenance Actions (MSBMA) or probability parameter will be specified in columns 27-32, when applicable. (See Table 8, CODES AND SYMBOLS.) |
| 27-32 | MSBMA or probability | When used with an F Selection Mode, this field gives MSBMA. When used with an E or G Selection Mode, this field enumerates the mutually exclusive probability (E) or non-mutually exclusive probability (G) path being taken. |
| 34-38 | Clock Number | The WUC of the subsystem in question (must agree with columns 13-17 of the F task). It identifies which failure clock triggered the network and is entered on every task record for that network. (See Table 8, CODES AND SYMBOLS.) |

| | | |
|---|---|---|
| 39 | Release | An asterisk indicates that the action being taken and those that follow do not interfere with the return of the aircraft to available status. |
| 40 | Type Task | A code to specify what type of task is to be performed. It may be scheduled (3), unscheduled (2), or a dummy task (5). (See Table 8, CODES AND SYMBOLS.) |
| 41 | Priority | The priority of that task network. A "1" indicates aircraft level, whereas a "3" is a shop level task. |
| 43-47 | Hours | Time taken to complete task in hours and tenths of an hour. |
| 48-50 | % Variance | The dispersion from the statistical mean of the distribution selected. In the case of the lognormal distribution, it is the standard deviation of the logs and is measured in percent. |
| 51 | Distribution Type | The type of statistical distribution selected for the task times. (See Table 8, CODES AND SYMBOLS.) |
| 53/60/67/74 | | N indicates the number of people or items of support equipment needed to do the task. |
| 54-58 | AFSC/AGE | The type of maintenance and repair specialist or the particular support equipment needed to do the work required by the task. |

Note: A skill level code is assigned in the fourth position of each specialist code unless an X, for unknown, is used. (See Table 8, CODES AND SYMBOLS, for specialists, skill level, and support equipment codes.)

| | | |
|---|---|---|
| 80 | Continuation | A "C" is entered in this column if additional fields (more than four) are needed to list specialists or support equipment whereby a continuation record follows. |

An example of a maintenance action coded in Extended Form 11 format is provided in Table 11. The networks represent a portion of those projected for the AMST landing gear with 5-skill level maintenance supported by conventional training and technical manuals.

The maintenance action network data file tends to become more complex as detailed information becomes available. The networks are extended to include additional tasks, parallel tasks, and tasks with multiple records (for example, the same task with several probability-driven task characteristics). At this point, the CHRT manager must decide whether or not to retain both a maintenance action network data file and an R&M model data file. The alternative is to reduce the maintenance action network data file when an R&M is required.

#### 4.3.4.3 R&M Model Data File

The maintenance action network (Extended Form 11) data file, described in Section 4.3.4.2, is only required if LCOM simulation is to be run. If the CHRT manager requires only the R&M model, only the R&M data file need be established. The R&M file is maintained on an 80-column record and represents maintenance action networks. However, these networks are limited in the number of tasks represented and are maintained in a different format. A detailed description of these networks and their development, maintenance, and use was discussed in Section 2.5. The description of the format and content of the R&M model data file follows.

Table 11 MAINTENANCE ACTION NETWORK EXTENDED 11 FORMAT

| | | | H | | 00010 | | AMST | NORMAL | DAILY | FLIGHT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J0000 | HINSP | J0001 | D | | 00010 | 31 | 10 | 29L | 143151 | | | |
| J0001 | HPREFT | J0002 | D | | 00010 | 31 | 5 | 29L | 143151 | | | |
| J0002 | HSTART | J0003 | D | | 00010 | 31 | 2 | 29L | | | | |
| J0003 | HTAXI1 | J0004 | D | | 00010 | 31 | 3 | 29L | | | | |
| J0004 | Z00000 | J0005 | S | | 00010 | 31 | | | | | | |
| J0005 | HTAXI2 | J0006 | D | | 00010 | 31 | 2 | 29L | | | | |
| J0006 | HPSTFT | J0007 | D | | 00010 | 31 | 2 | 29L | 143151 | | | |
| J0007 | DCRHT1 | J0008 | D | | 00010 | 31 | | | | | | |
| J0008 | CALLS1 | J0009 | C | | 00010 | 31 | | | | | | |
| J0009 | HREADY | | D | | 00010 | 31 | | | | | | |
| | | | H | | 13A00 | 21 | | | | | | |
| A3A00 | F13A00 | CSE000 | F | 29 | 13A00 | 21 | | | | | | |
| CSE000 | YOPT01 | A3A01 | E | .20 | 13A00 | 21 | | | | | | |
| CSE000 | YOPT02 | A3A02 | E | .20 | 13A00 | 21 | | | | | | |
| CSE000 | YOPT03 | A3A03 | E | .20 | 13A00 | 21 | | | | | | |
| CSE000 | YOPT04 | A3A04 | E | .20 | 13A00 | 21 | | | | | | |
| CSE000 | YOPT05 | A3A13 | E | .20 | 13A00 | 21 | | | | | | |
| A3A01 | T13A01 | A3A05 | E | .80 | 13A00 | 21 | t | 29L | 142354 | 142334 | 142350 | 14315RC |
| | T13A01 | | | | 13A00 | 21 | | | 143151 | 1D60 | | |
| A3A01 | T13A1C | | E | .20 | 13A00 | 21 | 11 | 29L | 142354 | 142334 | 142350 | 14315RC |
| | T13A1C | | | | 13A00 | 21 | | | 143151 | 1060 | | |
| A3A05 | H13A01 | | E | .80 | 13A00 | 21 | 17 | 29L | 142354 | 142350 | 14315R | 143151C |
| | H13A01 | | | | 13A00 | 21 | | | 1060 | | | |
| A3A05 | R13A01 | A3A09 | E | .20 | 13A00 | 21 | 28 | 29L | 142354 | 142334 | 142350 | 143151C |
| | R13A01 | | | | 13A00 | 21 | | | 1060 | | | |
| A3A02 | T13A02 | A3A06 | E | .80 | 13A00 | 21 | 6 | 29L | 142354 | 142334 | 142350 | 14315RC |
| | T13A02 | | | | 13A00 | 21 | | | 143151 | 1010 | INF2 | |
| A3A02 | T13A2C | | E | .20 | 13A00 | 21 | 11 | 29L | 142354 | 142334 | 142350 | 14315RC |
| | T13A2C | | | | 13A00 | 21 | | | 143151 | 1060 | INF2 | |
| A3A06 | M13A02 | | E | .80 | 13A00 | 21 | 17 | 29L | 142354 | 142350 | 14315R | 143151C |
| | M13A02 | | | | 13A00 | 21 | | | 1060 | INF2 | | |
| A3A06 | R13A02 | A3A09 | E | .20 | 13A00 | 21 | 28 | 29L | 142354 | 142334 | 142350 | 143151C |
| | R13A02 | | | | 13A00 | 21 | | | 1060 | INF2 | | |
| A3A03 | T13A03 | A3A07 | E | .80 | 13A00 | 21 | 6 | 29L | 142354 | 142334 | 142350 | 14315RC |
| | T13A03 | | | | 13A00 | 21 | | | 143151 | 1060 | 4TJ30E | 2TJ30NC |
| | T13A03 | | | | 13A00 | 21 | | | 1H27M | | | |
| A3A03 | T13A3C | | E | .20 | 13A00 | 21 | 11 | 29L | 142354 | 142334 | 142350 | 14315RC |
| | T13A3C | | | | 13A00 | 21 | | | 143151 | 1060 | 4TJ30E | 2T030NC |
| | T13A3C | | | | 13A00 | 21 | | | 1M27M | | | |
| A3A07 | M13A03 | | E | .80 | 13A00 | 21 | 17 | 29L | 142354 | 142350 | 14315R | 143151C |
| | M13A03 | | | | 13A00 | 21 | | | 1060 | 4TJ30E | 2TJ30N | 1M27M |
| A3A07 | R13A03 | A3A09 | E | .20 | 13A00 | 21 | 28 | 29L | 142354 | 142334 | 142350 | 143151C |
| | R13A03 | | | | 13A00 | 21 | | | 1060 | 4T0302 | 2T030N | 1M27M |
| A3A04 | T13A04 | A3A08 | E | .80 | 13A00 | 21 | 6 | 29L | 142354 | 142334 | 14350 | 14315RC |
| | T13A04 | | | | 13A00 | 21 | | | 143151 | 1060 | INF2 | 4TJ30EC |
| | T13A04 | | | | 13A00 | 21 | | | 2TJ30N | 1M27M | | |
| A3A04 | T13A4C | | E | .20 | 13A00 | 21 | 11 | 29L | 142354 | 142334 | 142350 | 14315RC |
| | T13A4C | | | | 13A00 | 21 | | | 143151 | 1060 | INF2 | 4TJ3060 |
| | T13A4C | | | | 13A00 | 21 | | | 2TJ30N | 1M27M | | |
| A3A08 | M13A04 | | E | .80 | 13A00 | 21 | 17 | 29L | 142354 | 142350 | 14315R | 143151C |
| | M13A04 | | | | 13A00 | 21 | | | 1060 | INF2 | 4TJ305 | 2TJ30NC |
| | M13A04 | | | | 13A00 | 21 | | | 1M27M | | | |
| A3A08 | R13A04 | A3A09 | E | .20 | 13A00 | 21 | 28 | 29L | 142354 | 142334 | 142350 | 143151C |
| | R13A04 | | | | 13A00 | 21 | | | 1060 | INF2 | 4TJ30E | 2TJ30NC |
| | R13A04 | | | | 13A00 | 21 | | | 1M27M | | | |
| A3A09 | SHOP | SA3A00 | D | | 13A00 | 21 | | | | | | |
| A3A13 | T13A05 | A3A14 | E | .80 | 13A00 | 21 | 6 | 29L | 142354 | 142334 | 142350 | 14315RC |
| | T13A05 | | | | 13A00 | 21 | | | 143151 | 1060 | 1MD3 | |
| A3A13 | T13A5C | | E | .20 | 13A00 | 21 | 11 | 29L | 142354 | 142334 | 142350 | 14315RC |
| | T13A5C | | | | 13A00 | 21 | | | 143151 | 1060 | 1MD3 | |
| A3A14 | M13A05 | | E | .80 | 13A00 | 21 | 17 | 29L | 142354 | 142350 | 14315R | 143151C |
| | M13A05 | | | | 13A00 | 21 | | | 1060 | 1N03 | | |

KEY FIELDS - Columns 1 to 11 are used as the key fields and, therefore, the format is common to all of the card types.

| Columns | Identifier | Definition |
|---|---|---|
| 1-2 | Card Type | Indicates the type of data to be found on the record (column 1) and indicates whether they reflect flight line, shop, or reference data (column 2).<br><br>CR Cross-reference<br>ILF AFSC with skill level - F/L<br>LS AFSC with skill level - shop<br>IMF Reliability mean values - F/L<br>PF Probability - F/L<br>PS P probability - shop<br>SF Support equipment - F/L<br>SS Support equipment - shop<br>TF Task time - F/L<br>TS Task time - shop |
| 4-10 | Equipment Identification (ID) Number | Defines the equipment in a series of codes showing type of weapon system (column 4), major system within the weapon system (column 5), functional grouping of the major system (column 6), and a numerical breakdown by operational function (such as radar navigation, radio navigation, or bombing navigation), subsystem, line replaceable unit, and shop replaceable unit (columns 7-10). These codes are determined by the user since they are configuration-dependent. An example of a data card encoding format used previously for equipment specifications is:<br><br>Column 4 Weapon system<br>Column 5 Major system<br>A avionics |

| | | |
|---|---|---|
| | | Column 6 Functional group<br>A air-ground-attack<br>C communications<br>I instruments<br>M miscellaneous<br>N navigation<br>Z core<br><br>Column 7 - Operational function<br>Column 8 - Subsystem<br>Column 9 - Line replaceable unit<br>Column 10 - Shop replaceable unit |
| 11-12 | Card Sequence | The sequential number of each record for a particular subsystem or line replaceable unit within a particular card type. |

FLIGHT LINE TASKS - Common to LF, PF, SF, and TF card types.

| Columns | Task Code | Task Name - Definition |
|---|---|---|
| 1-12 | | See key fields. |
| 14-18 | (A) | Set up the support equipment and maintenance stands that will be used by the technician to provide the power and the accessibility necessary to troubleshoot and repair the equipment that has failed. |
| 20-24 | (T) | Troubleshoot the reported discrepancy to isolate the cause and to determine if the repair action is to be a remove and replace or if the repair can be accomplished on the aircraft. |
| 26-30 | (C) | Cannot Duplicate (CND) - a troubleshooting action that cannot duplicate the reported discrepancy. |
| 32-36 | (R) | Remove & Replace (R&R) - once the discrepancy has been isolated to a particular LRU and a determination has been made that the repair is to be made in the shop, the faulty unit is removed and replaced by a spare. |
| 38-42 | (M) | On A/C Maintenance - if the discrepancy is minor and does not need shop repair, the equipment is maintained on the aircraft (A/C). For example, this includes adjustments; replacement of bulbs, knobs, and fuses; and aircraft wiring problems. |
| 44-48 | ($V_R$) | R&R Verification - after the removal and replacement of the faulty LRU is completed, a functional check is performed to verify the operational condition of the subsystem. |
| 50-54 | ($V_M$) | On A/C Maintenance Verification - upon completion of any on aircraft maintenance, a functional check is performed to verify the repair and operational condition of the subsystem. |

SHOP TASKS - Common to LS, SS, PS, and TS card types.

| Columns | Task Code | Task Name - Definition |
|---|---|---|
| 1-12 | | See key fields. |
| 20-24 | (W) | Bench Check & Repair - in-shop bench check and complete repair of a bad LRU, including cleaning, inspection, disassembly, adjustment, part replacement, reassembly, and lubrication of the complete LRU and any minor components. |
| 26-30 | (K) | Bench Check & CND - in-shop bench check is performed; if any discrepancy cannot be duplicated in the testing, the LRU is serviceable, and no repair is required. |
| 32-36 | (N) | Bench Check & NRTS - in-shop bench check or inspection shows that the LRU is not repairable this station (NRTS) because the shop is not authorized to accomplish the repair or the shop lacks the proper tools, equipment, facilities, technical skills, spare parts, time, or technical data to perform the repair. |
| 50-54 | (TD) | Test Drawer Repair - in-shop repair of the test station drawer (or combination of test equipment) that is needed to test the LRU being checked. |
| 56-60 | (TS) | Test Station Repair - in-shop repair of the entire test station that is needed to test the LRU being checked. |

CROSS-REFERENCE FILE (Card #1) - Same as hardware configuration/characteristics data file. Card #1 is not needed if that file is established.

| Columns | Identifier - Definition |
|---|---|
| 1-9 | See key field. |
| 11-12 | Card sequence is always 1. |
| 14-18 | Weight (in pounds) of the LRU. |
| 20-24 | Work unit code (WUC) used to identify each subsystem and LRU in the aircraft system (found on cards #1 and #2). |
| 26-27 | Quantity Per Aircraft of a particular subsystem or LRU in the aircraft system (found on cards #1 and #2). |
| 29-67 | Equipment name or description of the operational function assigned to a subsystem or LRU. |
| 75-76 | The number of LRUs in the subsystem for which input data have been provided, and the number of SRUs per LRU on LRU input cards. Input data are provided for those LRUs requiring a significant amount of unscheduled maintenance. |

CROSS REFERENCE FILE (Card #2)

| | |
|---|---|
| 1-9 | See key field. |
| 11-12 | Card sequence is always 2. |
| 20-24 | Work unit code (WUC) used to identify each subsystem and LRU in the aircraft system. |
| 26-48 | National Stock Number (NSN) assigned to the LRU. |
| 50-59 | AN/nomenclature of the particular subsystem or LRU described on card #1. |
| 65-80 | Manufacturer's Stock Number - when available. |

RELIABILITY MEAN VALUES (Flight Line)

| | |
|---|---|
| 1-12 | See key field. |

14-19 Mean flight-hours between maintenance actions ($MFHBMA_j$) shows the frequency of unscheduled maintenance activities required by a subsystem (j).

21-26 H factor - the ratio of the number of LRUs tested in the shop to the number of flightline removal actions. Only the value greater than unity of the ratio is input whereby the model automatically adds the integer "1" to the given value. The resultant portion that is greater than one accounts for any multiple LRU removals resulting from single flightline repair actions (such as two or more LRUs removed for one reported aircraft maintenance action). This factor is used as a multiplier of the shop probability of occurrences to obtain the actual number of shop maintenance actions eminating from flightline removal(s).

An example of an R&M data file is provided in Table 12. This file was developed during the demonstration of CHRT on projected AMST data. The sample selected is standard station keeping equipment (SKE), a subsystem of the avionics system. Although larger samples are available on the entire avionics and landing gear systems, the SKE sample was chosen for two reasons: (a) it covers both unscheduled and scheduled maintenance, and (b) it is a small, but totally representative sample which will facilitate presentation of the R&M output (ellipse 11) and life cycle cost estimates (ellipse 17) data groups.

#### 4.3.4.4 Maintenance Training Course Data File

The maintenance training course data file consists of maintenance training course data on specialty training, technical training, and on-the-job training. It is a hard copy file used to develop training course estimates.

Special training course data consist of the specialty training standard, the course chart, the plan of instruction for each AFSC, and the skill level for which a requirement is expected. These data should be obtained from the applicable technical training center. Technical training and on-the-job training course data should be obtained on the expected AFSC and skill level for comparable systems. These also are obtained from the applicable technical training center.

Table 12

R&M DATA FILE STANDARD STATION KEEPING EQUIPMENT

AMST STATION KEEPING EQUIPMENT R&M DATA – STANDARD
02

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CR DAN250 -1 | | 72L00 | 1 | S.K.E. Unscheduled Maintenance | | | | | 7 |
| CR DAN250 -2 | | 72L00 | | | | AN/APN-169A | | | |
| CR DAN251 -1 | 24.5 | 72LA0 | 1 | Radar & Antenna Assembly | | | | | 6 |
| CR DAN252 -1 | 34.0 | 72LC0 | 1 | Receiver/Transmitter | | | | | 12 |
| CR DAN253 -1 | 21.0 | 72LB0 | 1 | Coder/Decoder | | | | | 27 |
| CR DAN254 -1 | 15.0 | 72LAE | 1 | Electronic Mount | | | | | 3 |
| CR DAN255 -1 | 4.5 | 72LXX | 1 | Signal Data Converter | | | | | 3 |
| CR DAN256 -1 | 9.0 | 72LF0 | 1 | Indicator Coupler | | | | | 3 |
| CR DAN257 -1 | 0.8 | 72LAH | 1 | Audio Amplifier | | | | | 1 |
| CR DAN2S0 -1 | | 72L00 | 1 | S.K.E. Scheduled Maintenance | | | | | 1 |
| CR DAN2S3 -1 | 21.0 | 72LB0 | 1 | Coder/Decoder (Scheduled Maintenance) | | | | | 1 |
| CR DAN2S3 -2 | | | | | | | | | |
| SF DAN250 -1 | | EPU | EPU | EPU | EPU | | 1 | | |
| SF DAN2S0 -1 | | EPU | | EPU | | | 1 | | |
| LF DAN250 -1 | | 32851 | 32851 | 32851 | 32851 | | 3 | | |
| LF DAN250 -2 | | | | 32831 | 32831 | | | | |
| LF DAN250 -3 | | | | | 53153 | | | | |
| LF DAN2S0 -1 | | 32831 | | 32831 | | | 1 | | |
| LS DAN251 -1 | | 32851 | | 32851 | | | | 1 | |
| LS DAN252 -1 | | 32851 | 32851 | 32851 | | | | 2 | |
| LS DAN252 -2 | | 32831 | 32831 | | | | | | |
| LS DAN253 -1 | | 32851 | 32851 | 32851 | | | | 2 | |
| LS DAN253 -2 | | 32831 | 32831 | | | | | | |
| LS DAN254 -1 | | 32851 | 32851 | 32851 | | | | 2 | |
| LS DAN254 -2 | 32831 | 32831 | | | | | | | |
| LS DAN255 -1 | | | | 32851 | | | | 1 | |
| LS DAN256 -1 | | 32851 | 32851 | 31851 | | | | 1 | |
| LS DAN257 -1 | | | | 32851 | | | | 1 | |
| LS DAN2S3 -1 | | | 32851 | | | | | 1 | |
| TS DAN251 -1 | | 30 | | 20 | | | | | |
| TS DAN252 -1 | | 35 | 23 | 23 | | | | | |
| TS DAN253 -1 | | 35 | 23 | 23 | | | | | |
| TS DAN254 -1 | | 22 | 14 | 14 | | | | | |
| TS DAN255 -1 | | | | 03 | | | | | |
| TS DAN256 -1 | | 22 | 14 | 14 | | | | | |
| TS DAN257 -1 | | | | 03 | | | | | |
| TS DANS3 -1 | | | 25 | | | | | | |
| TF DAN250 -1 | | 15 | 15 | 20 | 14 | | | | |
| TF DAN2S0 -1 | | 01 | | 02 | | | | | |
| PF DAN250 -1 | 10000 | 7900 | 2100 | 6320 | 1580 | 6320 | 1580 | | |
| PF DAN2S0 -1 | 10000 | 10000 | 0000 | 10000 | 0000 | 10000 | 0000 | | |
| PS DAN251 -1 | | 0087 | | 0261 | | | | | |
| PS DAN252 -1 | | 0996 | 0125 | 1369 | | | | | |
| PS DAN253 -1 | | 2431 | 0167 | 0733 | | | | | |
| PS DAN254 -1 | | 0035 | 0005 | 0048 | | | | | |
| PS DAN255 -1 | | | | 0006 | | | | | |
| PS DAN256 -1 | | 0020 | 0003 | 0028 | | | | | |
| PS DAN257 -1 | | | | 0006 | | | | | |
| PS DAN2S3 -1 | | | 10000 | | | | | | |
| SS DAN251 -1 | | | | | | | | 0 | |
| SS DAN252 -1 | | | | | | | | 0 | |
| SS DAN253 -1 | | | | | | | | 0 | |
| SS DAN254 -1 | | | | | | | | 0 | |
| SS DAN255 -1 | | | | | | | | 0 | |
| SS DAN256 -1 | | | | | | | | 0 | |
| SS DAN257 -1 | | | | | | | | 0 | |
| SS DAN2S3 -1 | | | | | | | | 0 | |
| MF DAN250 -1 | 26.3 | 0.0000 | | | | | | | |
| MF DAN2S0 -1 | 78.0 | 0.0000 | | | | | | | |

### 4.3.5 Operations Requirements and Tasks Data Group

The operations requirements and tasks data group (ellipse 6) is used as an input to the resource assessment activity (block C) and to cost data bank preparation (block B). It consists of four files: (a) the operations crew and aircraft use, (b) operations schedule, (c) operations tasks, and (d) operator course material data files.

#### 4.3.5.1 Operations Crew and Aircraft Use Data File

This is a hard copy data file which provides summary statements of the mission need statement, generalized operational requirement, and/or operations plan. This information includes the crew composition and aircraft utilization data necessary for the cost data bank preparation (block B) activity and for resource assessment (block C). It is essential to the development of R&M model outputs (ellipse 11), operations manpower estimates (ellipse 12), and LCC estimates (ellipse 17). An example of the data required is given in Table 13 which was extracted from AMST demonstration data.

Table 13  AMST OPERATIONS CREW AND AIRCRAFT USE DATA FILE

OPERATIONS CREW DATA

| POSITION | Pilot | Copilot | Navigator | Loadmaster | Crewchief |
|---|---|---|---|---|---|
| RANK | 0-3 | 0-2 | 0-2 | E-5 | E-5 |
| YEARS OF SERVICE | 12 | 4 | 4 | 6 | 6 |

FLYING TIME PER AIRCRAFT

PEACETIME  1.8 hours/day on 5 days/week

WARTIME  4.0 hours/day on 7 days/week

#### 4.3.5.2 Operations Schedule Data File

This file contains the mission scenario necessary to perform resource assessment with LCOM. A squadron operations schedule is required to run the LCOM simulation. The LCOM simulation is one of several resource assessment techniques available in the logistic resource assessment activity (block C). The development of the mission scenario data is fully discussed in Reference 2 and the formatting of these data on LCOM Form 20 cards is described in Reference 8. These data are retained in the CDB on standard Hollerith cards and must be developed in close liaison with the operating activity so that it represents the most realistic system application. The operation schedule provides a profile of daily squadron activity listing pertinent factors such as take-off time, flight time, sorties per flight, and sortie time. A sample operations schedule in Form 20 format is provided in Table 14. The references must be reviewed for a detailed description.

#### 4.3.5.3 Operations Tasks Data File

The operations tasks data file provides a listing of operational tasks and generally identifies who will accomplish them. This data file is initially used in the resource assessment (block C) to develop operations training estimates (ellipse 13) and finally to develop the operations training course portion of the data group (hexagon 03), coordinated training/technical manual products. The operations tasks data file is established during the conceptual phase of acquisition and is continually expanded in detail until it is finalized in a formal task analysis performed on the actual equipment. Before the actual equipment becomes available, however, these tasks must be estimated by some method. In an aircraft acquisition program, a technique to accomplish task identification is by comparison to a similar system. On the AMST, this was accomplished by reference to the C-130 aircraft.

Initially, a preliminary task list is developed which identifies tasks unique to the new system and tasks similar to the old system that are expected to be reallocated on the new system. A limited sample preliminary operator task list drawn from the AMST CDB is provided in Table 15. This list identifies tasks unique to the AMST and tasks related to the flight engineer and navigator on the C-130 which are to be reallocated to the pilot.

Table 14 AMST OPERATIONS SCHEDULE FORM 20

```
20              HEADER RECORD
HEADER CARD IGNORED
LIST130 AMST  ADVANCED MEDIUM STOL AIRCRAFT EXOGENOUS MISSION SCENARIO
BEGIN 0.0
EXOG DATA FILE GENERATED FOR 130. DAYS. IDENT = AMST  ADVANCED MEDIUM STOL AI
DRAFT  EXOGENOUS MISSION
20     1   1   0730 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   0800 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   0830 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   0900 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   0930 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1000 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1030 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1100 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1130 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1200 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1230 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1300 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1330 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1400 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1430 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1500 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     1   1   1530 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   1999
20     3   1   1600 AMST   NDFLT   1 1 0   5.0H   .5N  2.0H   3.0H   3   3999
```

Table 15 SAMPLE PRELIMINARY OPERATOR TASK LIST

| FLIGHT PHASE | AMST UNIQUE | FLIGHT ENGINEER RELATED | NAVIGATOR RELATED |
|---|---|---|---|
| FLIGHT PLANNING | • INCREASED & DIFFERENT PERFORMANCE COMPUTATIONS | • PREPARE PERFORMANCE DATA | • PREPARE FLIGHT PLAN AND NAVIGATION LO |
| PREFLIGHT | • CHECK COMPLE STABILITY | | |
| ENGINE START/ TAXI/BEFORE TAKEOFF | • CHECK FLIGHT/STABILITY CONTROL SYSTEM FOR OPERATION IN ALL MODES SET FOR TAKEOFF | • CHECK/SET ALL SYSTEMS, SET FOR TAKEOFF<br>• CHECK ENGINE PERFORMANCE | • CHECK NAVIGATION AND COMMUNICATIONS EQUIPMENT. SET FOR TAKEOFF<br>• UPDATE HEADING AND POSITION DEVICES<br>• SET ALL AVIONICS FOR TAKEOFF |
| TAKEOFF/ CLIMBOUT | • MONITOR FLIGHT/STABILITY CONTROL SYSTEM<br>• ACCOMPLISH CONFIGURATION CHANGES | • SET/HOLD POWER MONITOR ALL SYSTEMS AND ADJUST AS NECESSARY | • NAVIGATE AIRCRAFT<br>• MONITOR DEPARTURE<br>• PROVIDE TIME/POSITION DATA<br>• ACCOMPLISH ROUTE CHANGES |
| CRUISE | • SET FLIGHT/STABILITY CONTROL SYSTEM FOR | • COMPLETE CRUISE | • NAVIGATE AIRCRAFT |

A series of expanded task lists is then developed which provides full task listings and integrates unique and reallocated tasks. A limited sample is shown in Table 16. The left-hand listing in Table 16 was already expanded to include unique and flight engineer-related tasks. In addition, the right-hand listing shows an update to incorporate navigator-related tasks and reallocate these tasks to the pilot and copilot.

The operations tasks data file is reviewed initially with comparable training course data to develop training estimates. The formal task analysis provides data for development of the actual training course. A complete preliminary and expanded operator task list may be found in AFHRL-TR-79-28 (which documents the results of a portion of the CHRT demonstration).

#### 4.3.5.4 Operator Course Material Data File

The operator course material data file contains the hard copy course control documents (training plans) for all skills and training phases required on a comparable system. These data, obtainable from the responsible comparable system training agency, are used in estimating the new training course length (ellipse 13). Data for the AMST were obtained from the C-130 training course, for example.

### 4.3.6 Intermediate Products Data Group

The intermediate products data group (ellipse 16) is the product of an integrated task analysis performed on actual hardware. This is normally accomplished during the late full-scale development or the early production stage. The intermediate products are developed on a well-defined equipment configuration. There is a set of products, and a file is required for each one. The content of this set may be modified based on the specific application. Major data files are (a) the preliminary task identification matrix (PTIM), (b) an expected user description, (c) technical manual/training trade-off ground rules, (d) a task analysis worksheet, (e) the annotated task identification matrix (ATIM), (f) a level-of-detail guide, and (g) the test equipment and tool use form (TETUF). These intermediate products not only suggest an allocation of task

Table 16 SAMPLE AMST EXPANDED OPERATOR TASK LIST

| | |
|---|---|
| ENGINE START/TAXI/BEFORE TAKEOFF | |
| Starting engines checklist. Starting sequence as required, pressures and temperatures in limits. | Starting sequence as required, pressure and temperature in limits. |
| Before taxi checklist, check all systems controls and displays as directed. | Before taxi checklist, check all systems controls and displays as directed. Check nav receivers radar and other nav systems. Taxi clearance Flight Check-in* |
| Taxi checklist. Systems, controls, and displays checked as required. | Taxi checklist. Systems, controls, and displays checked as required. Nav systems checked and set. |
| Before takeoff checklist. Configuration and systems checked and set. | Before takeoff checklist. Configuration and systems checked and set. Tower frequency. Formation check-in* |
| Line up checklist. Switches, controls, and engines set and checked for takeoff. | Line up checklist, Switches, controls, and engines set and checked for takeoff. Compass and nav systems checked and set. |
| TAKEOFF/CLIMBOUT | |
| Takeoff sequence aircraft control through roll and lift-off. | Power set, systems monitored. Nav systems monitored. |
| After takeoff checklist, turn and climb. Adjust power and airspeed. | Accomplish after takeoff checklist and responds to frequency change. Adjust configuration and check systems. Departure radios and nav equipment set. Departure frequency. Check-in* |
| Perform IMC SKE formation join-up. SKE (and AWADS) equipment airborne checks. | Set up enroute nav radios and euqipment. Assist pilot in formation join-up. Back up SKE with radar. Set up nav equipment for enroute Make appropriate entries in nav log. |

information to training and/or technical manuals, they also form the basis for the development of the coordinated training program and technical manual set. The intermediate products have been utilized only to support analysis of maintenance tasks. It seems reasonable to extend this technique to operator personnel also.

### 4.3.6.1 Preliminary Task Identification Matrix (PTIM) Data File

The PTIM is the initial intermediate product of the integrated task analysis. The purpose of the PTIM is to depict the maintenance task requirements for each item of equipment to the SRU level and to note the level (such as organizatinal, intermediate, or depot) at which the task is carried out. Presently, it is maintained in the CDB as a hard copy document.

Figures 6 and 7 show two types of PTIMs developed for the C-141 landing gear (used to simulate the AMST landing gear). The basic PTIM shown in Figure 6 (1 of 12 pages is presented) was developed to show major tasks and locations. The detailed PTIM shown in Figure 7 (1 of 3 pages is presented) was developed to indicate subtasks required to remove and replace a main landing gear brake. A basic PTIM is prepared early in the task analyses and detailed as the analysis proceeds. The column headings of the PTIM format are the same for both detail and basic types and are defined as follows.

FOUND IN TROUBLESHOOTING COLUMN

A check will be placed in this column when the malfucntion is uncovered during troubleshooting of a superordinate hardware item. The items checked are those that are replaced or repaired as the result of a troubleshooting routine.

CODE AND REFERENCE DESIGNATOR COLUMNS

The codes showing subordination (relationship of one item to another in terms of level-of-detail) should be as specified in MIL-M-008910A (AS) and should follow the guidelines suggested in AFHRL-TR-73-43 (I and II).

SYSTEMS HARDWARE ITEM COLUMN

The equipment items are listed in the row headings to the SRU or piece part level.

## Figure 6 BASIC LANDING GEAR PTIM

LANDING GEAR PRELIMINARY TASK IDENTIFICATION MATRIX (PTIM)

| FOUND IN TROUBLESHOOTING | CODE | | | | | SYSTEM HARDWARE ITEM | DRC CODE | REFERENCE DESIGNATOR | MAINTENANCE FUNCTION | | | | | | | | | | | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | |
| | | | | | | | | | ADJUST | ALIGN | CALIBRATE | CHECK OUT | TROUBLESHOOT | CLEAN | Disassemble/Assemble | INSPECT | LUBRICATE | OPERATE | REMOVE/REPLACE | REPAIR | SERVICE | |
| | 1 | | | | | Landing Gear System | GLG100 | C-141 | | | | | | | | | | | | | | |
| | 1 | 1 | | | | Main Gear | GLG110 | C-141 | | | | | | | | | | | | | | |
| | 1 | 1 | 1 | | | Mechanical Components | | | | | | | | | | | | | | | | |
| | 1 | 1 | 1 | 1 | 1 | STRUT | | | 1 | 1 | | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | |
| | 1 | 1 | 1 | 2 | | Piston Assembly | | | | | | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | |
| | 1 | 1 | 1 | 3 | | Cylindar Assembly | | | | | | 1 | 1 | | 1 | 0 | 0 | 1 | 1 | 1 | 0 | |
| | 1 | 1 | 1 | 4 | | Torque Arm Lower | | | | | | 1 | | | 1 | | 0 | | 1 | | | |
| | 1 | 1 | 1 | 5 | | Torque Arm Upper | | | | | | 1 | | | 1 | | 0 | | 1 | | | |
| | 1 | 1 | 1 | 6 | | Brake Link AFT | | | | | | 1 | | | 1 | | 0 | | 1 | | | |
| | 1 | 1 | 1 | 7 | | Brake Link Forward | | | | | | 1 | | | 1 | | 0 | | 1 | | | |
| | 1 | 1 | 1 | 8 | | Drag Brace Forward | | | | | | 1 | | | 1 | | 0 | | 1 | | | |
| | 1 | 1 | 1 | 9 | | Drag Brace AFT | | | | | | 1 | | | 1 | | 0 | | 1 | | | |
| | 1 | 1 | 1 | 10 | | Unlock Assembly | | | | | | 1 | | | 1 | | 0 | | 1 | | | |
| | 1 | 1 | 1 | 11 | | Down Lock Assembly | | | | | | 1 | | | 1 | | 0 | | 1 | | | |
| | 1 | 1 | 1 | 12 | | Bogie Beam Assembly | | | | | | 1 | 1 | | 1 | | 0 | | 1 | 1 | | |
| | 1 | 1 | 1 | 13 | | Axle | | | | | | 1 | | | 1 | | | | 1 | | | |
| | 1 | 1 | 1 | 14 | | Beam Posidoner | | | | | | 1 | | | 1 | | 0 | | 1 | | | |
| | 1 | 1 | 1 | 15 | | Shaft Assembly MLG Support | | | | | | 1 | | | 1 | | 0 | | 1 | | | |

## Figure 7 DETAILED LANDING GEAR PTIM

LANDING GEAR DETAILED PRELIMINARY TASK IDENTIFICATION MATRIX (PTIM)
(TASK -- REMOVE AND REPLACE MAIN LANDING GEAR BRAKE)

| FOUND IN TROUBLESHOOTING | CODE | | | | | SYSTEM HARDWARE ITEM | DRC CODE | REFERENCE DESIGNATOR | 1 ADJUST | 2 ALIGN | 3 CALIBRATE | 4 CHECK OUT | 5 TROUBLESHOOT | 6 CLEAN | 7 Disassemble/Assemble | 8 INSPECT | 9 LUBRICATE | 10 OPERATE | 11 REMOVE/REPLACE | 12 REPAIR | 13 SERVICE | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | | | | Landing Gear Systems | | | | | | | | | | | | | | | | |
| | 1 | 1 | | | | Main Landing Gear | | | | | | | | | | | | | | | | |
| | 1 | 1 | 1 | | | Mechanical Parts | | | | | | | | | | | | | | | | |
| | 1 | 1 | 1 | 32 | | Leveler Rod Assembly | | | | | | | | | 1 | | | | 1 | | | |
| | 1 | 1 | 1 | 32 | 1 | Cotter Pin | | | | | | | | | | | | | 1 | | | |
| | 1 | 1 | 1 | 32 | 2 | Nut | | | | | | | | | | | | | 1 | | | |
| | 1 | 1 | 1 | 32 | 3 | Washer | | | | | | | | | | | | | 1 | | | |
| | 1 | 1 | 1 | 32 | 4 | Washer | | | | | | | | | | | | | 1 | | | |
| | 1 | 1 | 1 | 33 | | Torque Link Assembly | | | | | | | | | | | | | 1 | | | |
| | 1 | 1 | 1 | 33 | 1 | Star Washer | | | | | | | | | | | | | 1 | | | |
| | 1 | 1 | 1 | 33 | 2 | Nut | | | | | | | | | | | | | 1 | | | |
| | 1 | 1 | 1 | 33 | 3 | Bolt | | | | | | | | | | | | | 1 | | | |
| | 1 | 3 | | | | Brake/Anti Skid | | | | | | | | | | | | | | | | |
| | 1 | 3 | 1 | | | Skid Detector | | | | | | 1 | 1 | | 1 | 1 | | 1 | 1 | | | |
| | 1 | 3 | 2 | | | Brakes | | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | |
| | 1 | 3 | 2 | 1 | | Rotor Discs | | | | | | | 1 | | 1 | 1 | | | 1 | | | |
| | 1 | 3 | 2 | 2 | | Spacer (Outer) | | | | | | | | | | | | | 1 | | | |
| | 1 | 3 | 2 | 3 | | Spacer (Inner) | | | | | | | | | | | | | 1 | | | |

SPECIAL CODE AND REFERENCE DESIGNATOR COLUMNS

An additional code column beyond that described by AFHRL-TR-73-43 (presently labeled DRC CODE) has been added. This is used to carry any designator which would facilitate cross-checking of data. The reference designator column should follow the guidelines provided in AFHRL-TR-73-43. It has been used here to indicate the reference aircraft.

MAINTENANCE FUNCTION COLUMNS

The maintenance function columns list appropriate maintenance functions. These functions are:

1. Adjust - to manipulate the equipment in some manner so as to bring it to some specified position or state; usually to bring it from some out-of-tolerance condition to a within-tolerance condition.

2. Align - to bring into precise adjustment or correct relative position by lining up.

3. Calibrate - to use special measurements or comparison with a standard for determining the accuracy, deviation, or variation in a piece of equipment and to correct where necessary.

4. Checkout - to perform specific operations to verify operational readiness of the equipment; to test.

5. Clean - to wash, scrub, or apply solvents to remove dirt, corrosion, or grease.

6. Disassembly/Assemble - to remove and replace the parts of an item for purposes of inspection, cleaning, repair, or replacement.

7. Inspect - to perform a visual, auditory, or tactile examination or check for specific conditions to determine the serviceability of an item by comparing its physical and mechanical characteristics with some standard.

8. Lubricate - to apply lubrication at specific locations.

9. Operate - to control equipment to achieve the intended function.

10. Remove/Replace - to interchange an unserviceable item with a serviceable one.

11. Repair - to restore an item to operable condition by means other than total replacement of a part.

12. Service - to perform operations required periodically (such as replenish consumable supplies) to keep an item in proper operating condition.

13. Troubleshoot - to isolate the source of a malfunction or failure to an item whose parts are replaceable or repairable.

Check-out and troubleshoot are treated as separate functions because one may occur without the other, especially in the case of scheduled maintenance.

The CHRT procedure departs from the PTIM format suggested in AFHRL-TR-73-43 (I and II) because the maintenance function cells are not divided diagonally. As a result, both the level of maintenance notation and the head, book, and joint notation can be entered in each cell. It is efficient to eliminate the clutter and prepare a separate matrix for both notations despite the added pieces of paper.

The cell entries for the PTIM are as follows.

- \- No maintenance task of this type is performed on the hardware item (this is not shown on the sample).
- O A maintenance task of this type is performed at the organizational level.
- I A maintenance task of this type is performed at the intermediate level.
- D A maintenance task of this type is performed at the depot level.
- Ⓓ A maintenance task of this type is performed at both the organizational and intermediate levels.

4.3.6.2 User Description Data File

The user description data file is prepared to guide the training and technical manual specialists in developing technical manual/training trade-off ground rules and in establishing the level-of-detail guide. It is maintained as a hard copy listing in the CDB and covers the full range of user personnel required to maintain the system. Various types of user descriptions are discussed in AFHRL-73-43. Although more detailed, they do fit into the basic format of the estimated user description, provided as follows.

ESTIMATED USER DESCRIPTION

The Estimated User Description (for the 431X2 career field) is that of the person(s) being trained with the use of task-oriented training supported by task-oriented technical manuals. The requirements are as follows.

Aptitude:

A minimum of 50 must be obtained in Mechanical through the use of Armed Forces Vocational Aptitude Battery (ASVAB) scoring criteria for USAF personnel.

Reading Level:

A reading level of more than 60 using the same scoring criteria must be obtained.

Intelligence:

Average (ASVAB).

Average Time in Service:

18 months.

Prior Indirect Training:

Three months of basic training.

Prior Direct Training:

Half of the personnel have AFSC + 30 days of OJT. The other half have eight weeks of task-oriented training.

Prior Military Work:

Half have two years of C-130 experience. The other half have none.

### 4.3.6.3 Technical Manual/Training Trade-off Ground Rules Data File

A set of ground rules which direct the technical manual/training trade-off also are developed through the integrated task analysis. These ground rules are similar for all systems but must be reviewed for appropriateness and modified for the particular weapon system of interest. They also must be adjusted for specific subsystems within the weapon system before they are established in the CDB. The application and use of these ground rules is discussed in Section 4.2.3.

The ground rules are retained in the CDB as a hard copy summary. Coupled with the detailed system-specific knowledge generated during the task analysis, these ground rules allow the task analyst to perform a training/aiding trade-off. An example developed for the CHRT demonstration follows.

The following are included in technical manuals:

1. Behavioral sequences that are complex and long and that would put a burden on memory.
2. Behavioral sequences that require extremely lengthy training/practice periods to produce sufficiently reliable performance.
3. Tasks that use reference information such as tables, graphs, flow charts and schematics, and tolerances.
4. Tasks that are aided by the presence of illustrations.
5. Tasks that involve complex discriminations or where similarity of cues causes confusion.
6. Tasks that are performed under stressful conditions that might degrade performance (except time stress).
7. Infrequently performed tasks.

8. Tasks that have a high probability of errors which are costly.

9. Tasks with branching step structures.

10. Tasks where low skill level personnel are used.

11. Tasks where personnel turnover is high.

12. Tasks where procedures change from time to time.

The following are included in training:

1. Tasks that are not easily described in book form.

2. Tasks that are not easily learned on the job (unless they can be included in technical manuals).

3. Tasks that need a great deal of practice for acceptable proficiency.

4. Tasks that have little room for errors which are costly.

5. Tasks which are performed frequently on the job.

6. Tasks requiring high speed (where the rate of stimulus inputs is high and response outputs are high).

7. Tasks that are performed under stress, especially time stress.

8. Tasks where environmental constraints interfere with or prohibit the use of aids.

9. Tasks performed by a large proportion of individuals in a given specialty.

These ground rules indicate placement of the major emphasis but all tasks must be covered to some degree in both the training program and technical manual.

#### 4.3.6.4 Task Analysis Worksheet Data File

The task analysis worksheet data file is a key intermediate product. Its initial base is the PTIM which provides hardware defintion. The worksheet data file is then completed through interview and job observation. The purpose of the worksheet file is to:

1. Identify and verify hardware elements and task steps.
2. Describe the cue and accompanying responses for each step.
3. Ascertain the sensory, motor, and cognitive demands on the technician.
4. Determine essentially how the technician knows what do to, when to do it, how to do it, and what feedback is available to indicate that it is done correctly.
5. List tools and equipment used.
6. Evaluate safety hazards and environmental factors.

The completed worksheets are maintained as hard copy in the CDB. They are used with the PTIM and the technical manual/training trade-off ground rules to prepare the annotated task identification matrix (ATIM) data file. Table 17 provides an excerpt from the task analysis worksheet data file established as a result of the integrated task analysis performed on the C-141 landing gear as part of the CHRT demonstration. Under each major subtask (such as "Remove Wheel and Tire"), the specific steps required to perform the task are listed, the equipment required to perform the step is identified, and appropriate notes regarding procedure, safety, and the like are made.

#### 4.3.6.5 Annotated Task Identification Matrix (ATIM) Data File

The ATIM data file provides a record of the training/technical manual trade-off. This file is prepared by training and technical manual specialists using the PTIM, the user description, the technical manual/training trade-off ground rules and the task analysis worksheet data files. The ATIM is retained in the CDB as hard copy in a format similar to the

Table 17 EXCERPT FROM TASK ANALYSES WORKSHEET DATA FILE

A. Remove Wheel and Tire

| *Steps:* | Equipment | Notes |
|---|---|---|
| 1. Inflate both landing gear struts | | Check T.O. for caution about 13" differential |
| 2. Remove forward and aft wheel chocks | | Safety precaution because chocks are kicked |
| 3. Disconnect leveler rod (37) | | |
| a) remove cotter pin (36) | pliers | |
| b) remove nut (35) | | |
| c) remove washer | | |
| d) detach leveler rod (37) | | Put nut & washers back on leveler rod for safe keeping |
| e) remove washer (38) | | |
| 4. *Jack axle until tire clears ground* | | Be sure leveler rod is disconnected. Make sure axle is raised high enough to provide clearance for new (thicker) tire. |
| 5. Depress upper portion of rudder pedals | | |
| a) Pull out parking brake handle | | |
| b) Release rudder pedal | | |
| (Note: If brake change, omit steps 6, 7 & 8) | | |
| 6. Remove valve cover (28) | | |
| 7. Using valve core tool, deflate tire | | |
| 8. Remove valve core | | Wait until tire pressure is below lbs. before proceeding with step 9. |
| 9. Remove snapring (23) | screwdriver | |
| 10. Remove hub cap (5) | | |
| 11. Remove grease retainer ring (9) | | To facilitate reassembly, place removed parts in the same order they were removed. |

PTIM. One of three pages of the complete ATIM for the "remove and replace main landing gear brake" task is shown in Figure 8. The unique annotations used in the ATIM are dictated by AFHRL-TR-73-43. These are H (head), B (book), and J (joint). They respectively indicate that task emphasis should be placed in training, technical manuals, or both.

#### 4.3.6.6 Level-of-Detail Guide

The level-of-detail guide is established as a guide for the actual technical manual preparation. It is developed with the user in mind and is used in conjunction with the task analysis worksheet data file and the TETUF to prepare the content of the technical manual. The level-of-detail guide, as used in CHRT, is more system-specific than that suggested by AFHRL-TR-73-43. A sample level-of-detail guide for tasks of the "remove and replace landing gear brake" type follows.

LEVEL-OF-DETAIL GUIDE

1. Disconnect leveler rod.

   Simple statement of steps as they occur in their proper code, for example:
   "Using pliers, remove the cotter pin"
   "Using wrench, remove nut"
   "Put nut and washer back on leveler rod for safe keeping"
   These steps will be accompanied by a blow-up diagram which shows the location of the rod and details the assembly.

2. Remove valve core and deflate tire.

   Simple statement of steps. The appropriate tire pressure, which must be reached before proceeding, will be specified. The use of the valve core tool and the tire gauge will be taught through training. Cautions will be listed.

3. Remove snapring, hub cap, grease retainer ring, felt grease seal, safety wire, skid detector screws and detector, cotter pin from lock ring, and axle nut.

Figure 8 LANDING GEAR DETAILED ANNOTATED TASK IDENTIFICATION MATRIX (ATIM)

TASK -- REMOVE AND REPLACE MAIN LANDING GEAR BRAKE

| FOUND IN TROUBLESHOOTING | CODE | | | | | SYSTEM HARDWARE ITEM | DRC CODE | REFERENCE DESIGNATOR | 1 ADJUST | 2 ALIGN | 3 CALIBRATE | 4 CHECK OUT | 5 TROUBLESHOOT | 6 CLEAN | 7 Disassemble/Assemble | 8 INSPECT | 9 LUBRICATE | 10 OPERATE | 11 REMOVE/REPLACE | 12 REPAIR | 13 SERVICE | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | | | | Landing Gear System | | | | | | | | | | | | | | | | H = Hand<br>B = Book<br>J = Joint |
| | 1 | 1 | | | | Main Landing Gear | | | | | | | | | | | | | | | | |
| | 1 | 1 | 1 | | | Mechanical Parts | | | | | | | | | | | | | | | | |
| | 1 | 1 | 1 | 32 | | Leveler Rod Assembly | | 37 | | | | | | | H | | | | | | | |
| | 1 | 1 | 1 | 32 | 1 | Cotter Pin | | 38 | | | | | | | | | | | H | | | |
| | 1 | 1 | 1 | 32 | 2 | Nut | | 36 | | | | | | | H | | | | | | | |
| | 1 | 1 | 1 | 32 | 3 | Washer | | 34 | | | | | | | H | | | | | | | |
| | 1 | 1 | 1 | 32 | 4 | Washer | | 38 | | | | | | | H | | | | | | | |
| | 1 | 1 | 1 | 33 | | Torque Link Assembly | | 31 | | | | | | | H | | | | | | | |
| | 1 | 1 | 1 | 33 | 1 | Star Washer | | 32 | | | | | | | | | | | H | | | |
| | 1 | 1 | 1 | 33 | 2 | Nut | | 33 | | | | | | | H | | | | | | | |
| | 1 | 1 | 1 | 33 | 3 | Bolt | | 30 | | | | | | | H | | | | | | | |
| | 1 | 3 | | | | Brakes/Anti Skid | | 20 - 8 | | | | | | | | | | | | | | |
| | 1 | 3 | 1 | | | Skid Detector | | 8 | | | | | | | B | B | | | | | | |
| | 1 | 3 | 2 | | | Brakes | | 20 | | | | | | | | | | | | | | |
| | 1 | 3 | 2 | 1 | | Rotor Discsq | | | | H | | | | | J | | | | | | | |
| | 1 | 3 | 2 | 2 | | Spacer (Outer) | | 19 | | | | | | B | B | J | | | | | | |
| | 1 | 3 | 2 | 3 | | Spacer (Inner) | | 21 | | | | | | B | B | J | | | | | | |

Simple statement of steps with suggestions to keep things in order of removal to facilitate installment. Also inspect for wear.

4. Inspect wheel for defects.

   The specific types of defects likely to be encountered will not be described. They will be covered in training: The job guide will only direct the technician to inspect.

5. Remove axle nut and lock ring.

   Simple statement. The use of the spanner wrench will be taught in training.

6. All the steps up through removal of the tire are listed in a straight-forward manner with accompanying illustrations. The washing and lubricating of seals, rings, etc. will be covered in training. However, the material used will be listed in the book.

7. Brake removal and installation.

   Steps are listed in a straight-forward manner. The steps dealing with the torque link will be described in somewhat more detail, especially the cues required to align/install/etc. the star washer, bolt, and nut. For example, there will be information on such things as how to discern when the bolt is properly installed, when the nut is tight, etc. These steps will also be covered in training. The cautions involving brake removal and installation will be emphasized. Here again, cues will be emphasized such as how much of the spacer should be showing when brake is properly installed.

8. Tire installation.

   The most difficult part of putting the tire back on is the alignment of the rotor and stator discs of the brake with the wheel. This will be mentioned in the book but it will be presented in training. Again, mention will be made of the cues that are visible when there is proper installation.

9. Installation of parts after wheel is installed.

   Step-by-step instruction. However, the installa[illegible] the lock ring and axle nut will receive more [illegible]

Emphasis will be placed on the necessity for keeping lock ring keys in the axle lock slot while tightening the nut and on how to determine proper installation. Correct insertion of the cotter pin will be described. All of this will be covered in training also. Safety wiring will be covered by the training and requires no further description.

10. Installing leveler rod.

    General instructions. This will be covered in training.

#### 4.3.6.7 Test Equipment and Tool Use Form (TETUF) Data File

The TETUF data file is initiated early during the integrated task analysis and maintained in the CDB as a hard copy file. Initially, it is used to identify the test equipment and tools required and their functions. Finally, the form is used in conjunction with the ATIM to document the training/technical manual trade-off. A sample TETUF is provided in Figure 9 for the valve core tool using during landing gear maintenance.

### 4.3.7 Alternatives Data Group

The alternatives data group (ellipse 7) consists of three files: the system/subsystem design option decision tree, the support design option decision tree, and alternative listing data files. The source of data and methodology for preparing each file are detailed in Section 5. The files are described as follows.

#### 4.3.7.1 System/Subsystem Design Option Decision Tree (DODT) Data File

The system/subsystem DODT data file consists of a system DODT and the subsystem DODTs required to cover critical design areas. These trees document the actual design path, which include past alternatives and the alternative paths that future design may take. Upon completion of design, the DODT reflects the actual design. The trees are retained in the CDB both as "D"

Figure 9 SAMPLE TETUF FOR THE VALVE CORE TOOL USED DURING LANDING GEAR MAINTENANCE

## TEST EQUIPMENT AND TOOL USE FORM

______________ Equipment Nomenclature　　　　Date ______________

______________ Equipment Number　　　　Analyst ______________

| FUNCTIONS | JPA/Training Trade-Off | |
|---|---|---|
| | Information to be Included in JPA | Information to be given in Training |
| To remove valve from tire<br><br>To deflate tire | 1. Using valve core tool deflate tire<br><br>2. Cautions<br><br>3. Indicate what pressure must be reduced to before proceeding with further tasks | 1. How to use tool<br><br>2. Hazards and cautions |

size drawings and as 8 x 11 or 8 x 14 reductions. The "D" size drawings are prepared and maintained. The reductions are provided for accessibility and ready reference.

The DODTs are used by the CHRT manager primarily to identify and anticipate system design decisions where alternative assessments may be required. They are also used to identify the possible alternatives at any given design point. Simple subsystem DODTs for projected AMST avionics are provided in Figure 10. These trees are annotated to depict actual paths for the two-man flight deck (2MFD) and three-man flight deck (3MFD) options.

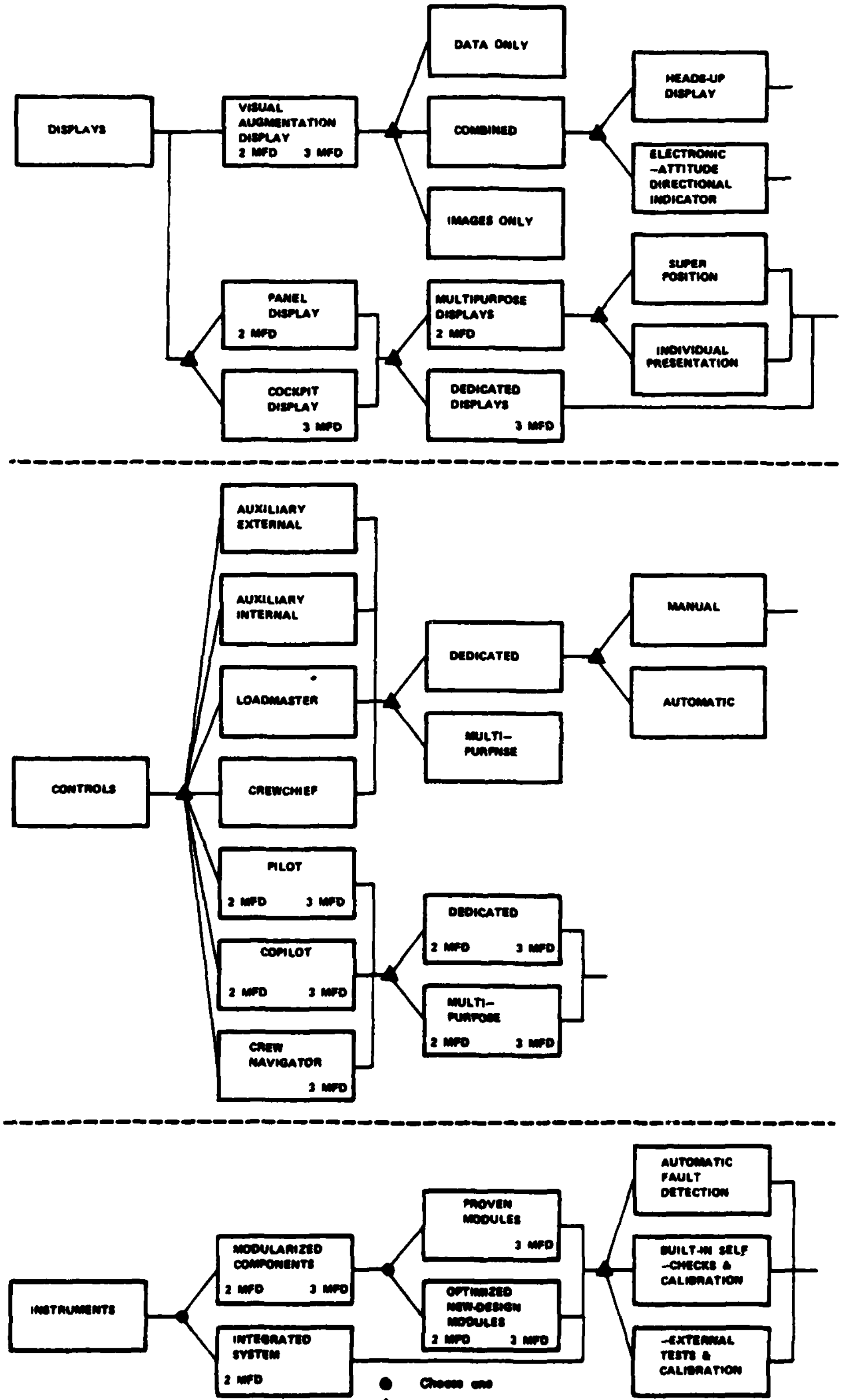
#### 4.3.7.2 Support DODT Data File

The support DODT file is similar to the support design data file in that it represents the integrated logistic support (ILS) elements. In addition, the support DODT indicates the various acceptable support design options. This file is similar, physically and in use, to the system/subsystem trees. A sample of the support option tree developed for the AMST avionics and landing gear was given in Figure 8. The tree in Figure 11 is annotated to indicate the potential paths for either a conventional (C) or task-oriented (T) personnel/training/ technical manual approach.

#### 4.3.7.3 Alternative Listing Data File

The alternative listing data file is a simple list of viable alternatives which would affect system or support design (such as takeoff gross weight, landing field roughness, and cruising speed). However, as described, the alternatives cannot be presented in a DODT.

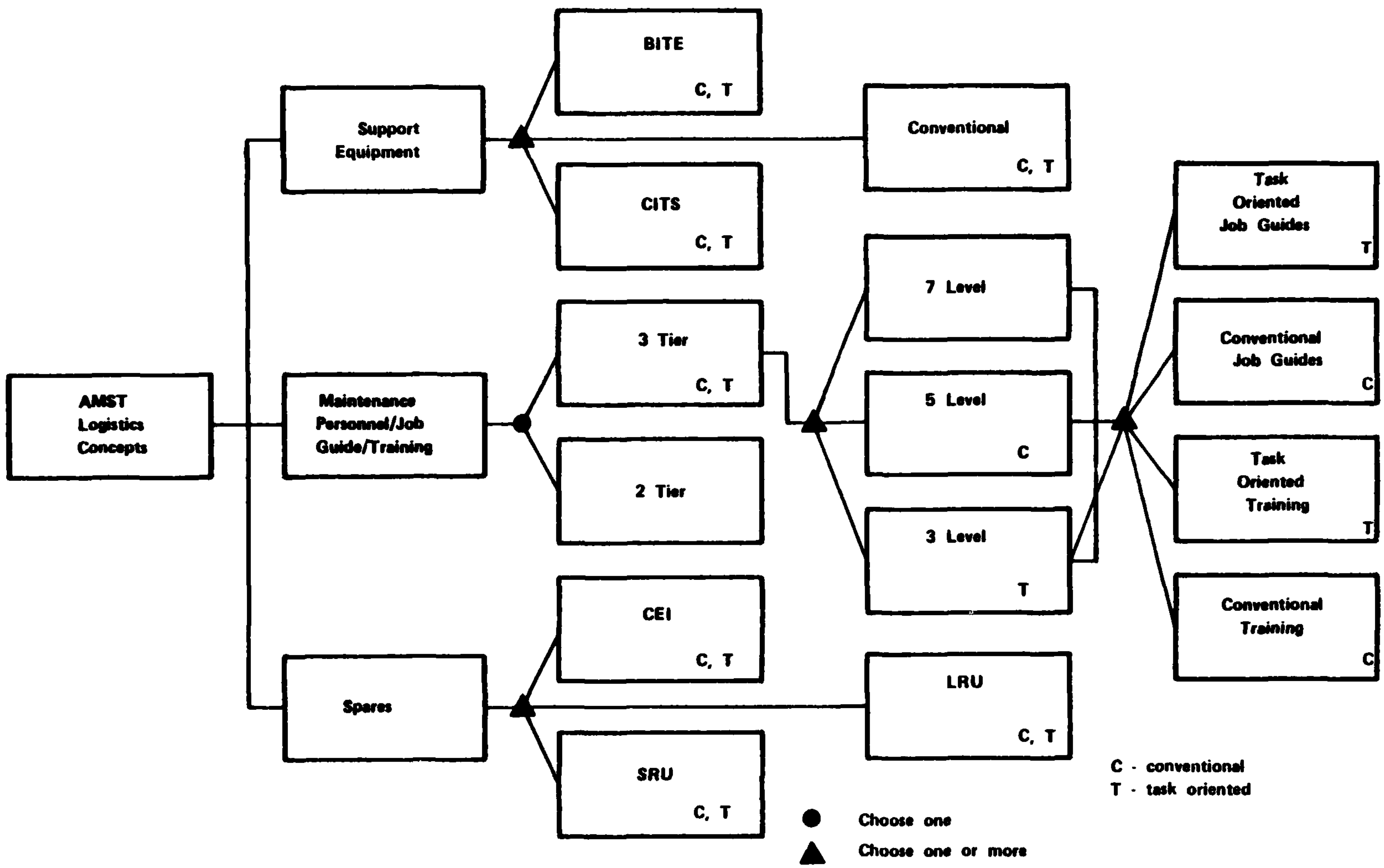
SELECTED PORTIONS OF SUBSYSTEM DESIGN OPTION DECISION TREES – PROJECTED AMST AVIONICS




● Choose one

▲ Choose one or more

Figure 11 AMST SUPPORT DESIGN OPTION DECISION TREE



# V. COST DATA BANK PREPARATION

## 5.1 OVERVIEW

Cost data bank preparation includes the cost data bank preparation activity (block B) and the cost/cost-related data group (ellipse 8). The subject is singled out because it involves a unique and separate activity, the sole purpose of which is to prepare a set of data for the exclusive use of the life cycle model, the RMCM.

## 5.2 THE COST DATA BANK PREPARATION ACTIVITY

The cost data bank preparation activity is fully documented along with the RMCM which it supports in an AFHRL report (Reference 9). It is a completely disciplined activity and results in a well-defined data group. Cost data bank preparation draws on both external data sources (ellipse 1) and the products of the program definition, comparability, and task analysis activities (ellipses 2 to 7) to quantify the data elements of the cost/cost-related data group.

The data elements of the cost/cost-related data group and their values are prepared in various ways. These elements and values can be broadly classified into five categories:

1. Scenario inputs
2. Precomputed values
3. Standard values
4. Historical estimates
5. Specifically developed estimates

These categories also tend to be homogeneous confidence groupings because they are drawn from similar sources. The following subsections describe each of the five categories and the types of sources from which values are obtained during the cost data bank preparation activity.

### 5.2.1 Scenario Inputs

Scenario inputs relate to considerations such as the number of sites, number of aircraft per site, flying hour program, and time frames. The values for these inputs are established from the operational, environmental, and equipment standards described for the weapons system deployment. The confidence in these estimates is high because, rather than being unspecified, they are assigned scalar values that are governed by operational requirements.

### 5.2.2 Precomputed Values

Computed values are higher level terms in the hierarchical order of the cost equations within the RMCM (such as support investment). The cost equations that compute and use these data are contained in the RMCM Users Guide. Values for these higher level terms also may be precomputed and inserted in the cost/cost-related data bank to be used as a substitute for an actual computed value if lower level data are not available for computation. When all lower level elements necessary to calculate a higher order value are present, even if zero, the RMCM should supersede any assigned value for that higher order element. Reliability estimates for precomputed values range from high to low, depending on the value and source of information.

### 5.2.3 Standard Values

Standard values are those that are obtained from Government sources. These data usually have been developed by Government agencies from historical cost-accounting information or special studies. The documentation sources from which these data are obtained are listed in the references and include the following.

| Reference Number | Reference |
|---|---|
| 11 | AFM 25-5 |
| 12 | AFM 26-3 |
| 13 | AFR 173-10, Volumes I and II |
| 14 | AFRP 177-1 |
| 16 | ATC/ACM Letter |

Accuracy of these values can be expected to vary. For example, a pay rate increase for a specific grade and fiscal year would be exact; a series of pay rate increases averaged over a period of years would be less exact; and a pay rate increase assumed for future years and based on past increases would be least exact. In all of these cases, however, the listed references could be used.

### 5.2.4 Historical Estimates

Historical estimates on actual equipment generally include those data values which are judgemental and/or dependent on estimates derived from comparable system historical experience. Data in this category include those normally furnished by the contractor based on the characteristics of a particular design configuration. Actual historical data (including cost for the particular subsystem under study) are used when available, but comparable item historical values which are properly adjusted may be used in cases when the subsystem has not yet been fielded. Included in this category of historical estimates is the use of reasonable or accepted values in estimating relationships. An example is the use of a proportion of the unit cost of an item as the value to allocate to spares procurement. Sources of historical cost/cost-related data include the following. A reference number is provided where applicable.

| Reference Number | Name Used in Source Column |
|---|---|
| 17 | K051-PN8L |
| - | Manpower Source Listing |
| - | Uniform Airman Records |
| - | Technical Training School Course Charts |
| - | Design/Logistics Support Data |
| - | National Stock Catalog/Comparable Item Estimate |
| - | Reasonable Values |
| - | Unofficial Historical Estimates/Expert Opinion |

The accuracy of values chosen for items in this category ranges from low to medium. The accuracy is highly dependent on the validity of the historical data sources, as well as the degree of comparability between a subsystem and its historical reference.

### 5.2.5 Specially Developed Estimates

Where no suitable source exists, the cost estimating relationship may have to be developed for a specific element. An example is the estimation of the number of page and page types for technical manuals. Such relationships were developed as part of this study and are described in Reference 13. Similar situations are likely to occur in any application of CHRT.

## 5.3 DATA OUTPUT OF THE COST DATA BANK PREPARATION ACTIVITY

The output of the cost data bank preparation activity consists solely of the cost/cost-related data group. This data group is comprised of a data file for each baseline and alternative under consideration. These data files are maintained in the CDB on Hollerith cards which are then used as a direct input to the life cycle cost assessment activity (block D). Sources for the cost/cost-related data group were described in the previous subsection. A sample card listing of the cost/cost-related data file required to support the projected AMST stationkeeping equipment life cycle cost assessment is shown in Table 18 as an example.

A summary of the cost/cost-related data group content is provided here. A complete understanding, however, can only be obtained from Reference 9.

The record cards listed in the example have a standard format. The input record format, for the key fields, is the same for the cost and the R&M input data (see Section 4.3.4.3) whereby columns 1 and 2 provide the card type code; columns 4 through 10 provide identification of the equipment or manpower such as line replaceable unit (LRU) or subsystem identifier, support equipment code, or Air Force Specialty Code (AFSC); and, columns 11 and 12 contain a dashed sequence number for continuation of data applicable to a specific piece of equipment or AFSC.

There are 148 possible cost data elements contained in a cost/cost-related data bank. These elements are segregated into ten types and are recorded in columns 17 through 80 on one of 23 record card configurations. The types of data are as follows.

Table 18 COST/COST-RELATED DATA FILE – STANDARD STATIONKEEPING EQUIPMENT

AMST STATION KEEPING EQUIPMENT COST DATA – STANDARD

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| VE | RECUR | -1 | 0 | 0 | 0 | 0 | | | | |
| VE | RECUR | -2 | | 0 | 0 | | | | | |
| VE | NRECUR | -3 | | 0 | 0 | 0 | 0 | 0 | | 0 |
| VE | NRECUR | -4 | 0 | 0 | | | 0 | 0 | | |
| VI | DAN251 | -1 | 6000 | | 0.01 | 0.05 | | 0.1667 | 600 | |
| VI | DAN252 | -1 | 24000 | | 0.01 | 0.05 | | 0.1667 | 2400 | |
| VI | DAN253 | -1 | 18000 | | 0.01 | 0.05 | | 0.1667 | 720 | |
| VI | DAN254 | -1 | 3880 | | 0.01 | 0.05 | | 0.1667 | 390 | |
| VI | DAN255 | -1 | 3500 | | 0.01 | 0.05 | | 0.1667 | 350 | |
| VI | DAN256 | -1 | 4540 | | 0.01 | 0.05 | | 0.1667 | 450 | |
| VI | DAN257 | -1 | 260 | | 0.01 | 0.05 | | 0.1667 | 30 | |
| VI | DAN253 | -1 | 0 | | 0.01 | 0.05 | | 0.1667 | 0 | |
| VI | DAN251 | -2 | 0 | 0 | 0 | | | | | |
| VI | DAN252 | -2 | 0 | 0 | 0 | | | | | |
| VI | DAN253 | -2 | 0 | 0 | 0 | | | | | |
| VI | DAN254 | -2 | 0 | 0 | 0 | | | | | |
| VI | DAN255 | -2 | 0 | 0 | 0 | | | | | |
| VI | DAN256 | -2 | 0 | 0 | 0 | | | | | |
| VI | DAN257 | -2 | 0 | 0 | 0 | | | | | |
| VI | DAN253 | -2 | 0 | 0 | 0 | | | | | |
| VN | 32831 | -1 | 30.0 | 448.40 | 58.25 | 372 | | 0 | | .676 |
| VN | 32851 | -1 | | | | | 0. | 2512 | | .254 |
| VN | 53153 | -1 | | | | | 0 | 2834 | | .246 |
| VN | 32831 | -2 | 4.96 | 2.34 | 0.50 | | | 3.13 | 2.71 | |
| VN | 32851 | -2 | 6.25 | 2.86 | 1.00 | | | 3.13 | 2.23 | |
| VN | 53153 | -2 | 6.25 | 2.86 | 1.00 | | | 3.13 | 2.23 | |
| VS | SCALAR | -0 | 0 | 0 | 0 | 0 | 0 | 1978 | | |
| VS | SCALAR | -1 | 0.13 | 0.36 | 0.53 | 0.30 | 0.10 | 0.06 | | 0 |
| VS | SCALAR | -2 | 826.21 | 862.37 | 223.32 | 1428.83 | 706.25 | 1380.22 | 973.89 | 0.25 |
| VS | SCALAR | -3 | 0 | 0 | | 0 | 0 | | 0. | |
| VS | SCALAR | -4 | | | | | | | 0.10 | 0.05 |
| VS | SCALAR | -5 | 56.16 | 143.04 | 27.73 | 0.53 | 0.99 | 1.36 | 0 | 0 |
| VS | SCALAR | -6 | | 274 | 3889 | 2725 | 1920 | 0.60 | 6 | 15 |
| VS | SCALAR | -7 | 46 | 2 | 38.97 | 103.92 | 0 | 0.5 | 0.15 | 0.50 |
| VS | SCALAR | -8 | 2080 | 98350 | 491760 | 312630 | 902740 | 0 | 0 | 0 |
| VS | SCALAR | -9 | 0.07 | 0 | 1 | 0 | 0 | 1 | 1 | 0.09 |

| Type of Data | | Number Record Cards |
|---|---|---|
| 1. | Recurring cost elements | 2 |
| 2. | Nonrecurring cost elements | 2 |
| 3. | Line replaceable unit (LRU) data | 2 |
| 4. | Subsystem data | 1 |
| 5. | Support equipment data | 2 |
| 6. | Depot support equipment data | 1 |
| 7. | Aircrew data | 1 |
| 8. | Personnel training data by AFSC | 1 |
| 9. | On-off equipment data by AFSC | 1 |
| 10. | Single value variables for use in various equations | 10 |
| | | 23 Total |

Up to eight data items may be assigned per card with each data item allowed eight columns (such as 17-24, 25-32, ..., 73-80). The data item is always right-justified with appropriate decimal points included. Table 19 lists the 148 data elements by data element code, column number, description, and source of data.

Table 19 COST/COST-RELATED DATA

| Code | Column No.'s | Description | Source |
|---|---|---|---|
| CARD TYPE VE-1 RECURRING COST ELEMENTS | | | |
| COO | 17-24 | Cost of other operations manpower including command staff, security, and other deployed personnel | Historical estimate |
| CAC | 25-32 | Cost of aircrew | Computed value |
| COP | 33-40 | Cost of operations personnel | Computed value |
| CFL | 41-48 | Cot of fuel | Computed value |
| COM | 49-56 | Cost of on equipment maintenance | Computed value |
| CSM | 57-64 | Cost of intermediate shop maintenance | Computed value |
| CPT | 65-72 | Cost of maintenance personnel training | Computed value |
| CSP | 73-80 | Cost of replacement spares | Computed value |
| CARD TYPE VE-2 RECURRING COST ELEMENTS (continued) | | | |
| CDR | 17-24 | Cost of depot maintenance | Computed value |
| CSE | 25-32 | Cost of maintaining support equipment | Computed value |
| CSW | 33-40 | Cost of software support | Computed value |
| CJG | 41-48 | Cost of supporting maintenance manuals | Computed value |
| CIM | 49-56 | Cost of inventory management | Computed value |
| CARD TYPE VE-3 NON-RECURRING COST ELEMENTS | | | |
| CRD | 17-25 | Cost of research and development | Historical estimate |
| CSI | 25-32 | System investment costs | Computed value |
| COI | 33-40 | Support investment costs | Computed value |
| CPP | 41-48 | Cost of procurement | Computed value |
| CPM | 49-56 | Cost of project management | Historical estimate |
| CPTI | 57-64 | Cost of initial maintenance personnel training | Computed value |
| CSPI | 65-72 | Cost of spares investment | Computed value |
| CDRI | 73-80 | Cost of depot support | Computed value |
| CARD TYPE VE-4 NON-RECURRING COST ELEMENTS (continued) | | | |
| CSEI | 17-24 | Cost of base level support equipment investment | Computed value |
| CSWI | 25-32 | Cost of software acquistion | Computed value |
| CJGI | 33-40 | Cost of maintenance manuals | Computed value |
| CIMI | 41-48 | Cost of non-recurring inventory management | Computed value |
| CFAI | 49-56 | Cost of facilities investment | Computed value |
| CDP | 57-64 | Cost of system disposal in constant year dollars of the baseline year | Historical estimate |

# VI. RESOURCE ASSESSMENT

## 6.1 OVERVIEW

Resource assessment includes the resource assessment activity (block C) and its products, the data groups represented by elipses 9 to 15 on Figure 18. These are the:

1. LCOM output data group, ellipse 9.
2. Expected value model (EXPVAL) data group, ellipse 10.
3. R&M model data group, ellipse 11.
4. Operations/support data group, ellipse 12.
5. Training estimates data group, ellipse 13.
6. Technical manual estimates data group, ellipse 14.
7. Training/aiding matrix data group, ellipse 15.

The resources assessed by the activity and included in these data groups are manpower quantity, skills, and skill levels; support equipment requirements; system/subsystem reliability and maintainability; training course length; and, technical manual page quantity and page type.

Each assessment directly reflects the following elements of the system design and the support plan.

1. Hardware design/configuration.
2. The maintenance concept.
3. Personnel/manpower plans.
4. Training concept.
5. Technical manual requirements.
6. The support equipment approach.
7. The spares philosophy.

The resource assessment activity uses one or more of several different models and techniques integrated by CHRT. Each model and/or technique is chosen to perform a specific assessment. The models and techniques available, along with the resources which they assess, are briefly described as follows.

PRECEDING PAGE BLANK-NOT FILMED

1. LCOM, a dynamic simulation program, may be used to assess maintenance manpower and support equipment requirements.

2. The expected value model, an average value program, is usually implemented as a debugging tool for LCOM. However, it may also be used to assess maintenance manpower and support equipment requirements. It aggregates maintenance manpower and support equipment requirements in two categories: on-equipment (flightline) and off-equipment (shop).

3. The R&M model is also an average value model. However, it was specifically developed to assess maintenance manpower and support equipment requirements and to provide direct interaction with a companion cost model. The R&M model aggregates maintenance manpower and support equipment requirements and to provide direct interaction with a companion cost model. The R&M model aggregates maintenance manpower and support equipment requirements into seven flightline categories and three shop categories.

4. Manual techniques, developed or under development, are used to prepare operations and support manpower estimates.

5. A comparability technique is used to estimate course length and content. Different techniques are used for maintenance and operations.

6. A prototype computer program estimates the quantity of technical manual pages and types of pages.

7. A prototype computer program identifies the degree of coverage required in training and technical manuals for specific tasks.

## 6.2 THE RESOURCE ASSESSMENT ACTIVITY

The logistics resource assessment activity (block C) draws on the data groups represented by ellipses 2 through 7. This activity processes these data using specific resource assessment models and techniques. The following subsections discuss the possible models and techniques. Where a model or technique is documented, a reference will be supplied.

### 6.2.1 LCOM Simulation

As implemented in CHRT, LCOM operates from a maintenance action network data file and an operations schedule data file. The basic output of the simulation is the performance summary report which is used to assess maintenance manpower and support equipment requirements. There are also several auxiliary reports that may be obtained as required. The total output of LCOM is stored in the LCOM output data group (ellipse 9).

LCOM is a Monte Carlo model. As such, it is sensitive to the dynamics of the operational scenario. The output, therefore, may be used to identify peak and minimum requirement periods. The simulation may then be used to evaluate trade-offs such as revised operational scheduling or increased manpower. (The LCOM simulation is documented in Reference 8.)

One capability of the LCOM model not documented in the reference is its application to support equipment maintenance action networks. A technique has been developed to model the maintenance action networks for the support equipment required by a weapon system or major system. Application of this technique not only allows determination of support equipment usage requirements, but also determination of the number of support equipment units required to meet the use.

### 6.2.2 The Expected Value Model (EVM = EXPVAL)

The expected value model, documented in References 19 and 20, was originally developed as a program with a quick answer capability and as a debugging tool for LCOM. It is a program which operates directly from the LCOM Extended Form 11 data, i.e., the maintenance activity network data file. Its Extended Form 11 data base contains the network string of required maintenance tasks for each AFSC and item of support equipment. The sum of the absolute probabilities of occurrence of each task multiplied by the respective task times yields the "expected" total maintenance time for each AFSC and use time for each item of support equipment. Resource requirements are categorized simply as "on" (flightline) or "off" (shop) equipment maintenance and are accumulated at the subsystem level in the EXPVAL output data groups (ellipse 10). The EXPVAL can process any Extended Form 11 data base, regardless of the complexity of the task structure. This estimate is useful to assess the general impact of a deployment scenario on manpower and support equipment requirements.

### 6.2.3 The R&M Model

Like the expected value model, the R&M model is also an average value model (documented in References 21 and 22). It quantifies the average requirement but does not compute excursions about this value that are a direct result of the scheduling within a specific operational scenario. This deficiency in relationship to a Monte Carlo simulation, however, is acceptable under many circumstances; particularly when the limited accuracy of the data does not justify a dynamic simulation or when there is a need to evaluate several approaches and/or to quickly estimate requirements. The R&M model and the expected value model are also similar in that they may be used to assess maintenance manpower and support equipment requirements.

The R&M model is designed to accept seven flightline and thee shop tasks. The maintenance manpower and support equipment requirements, therefore, are summed in each of the 10 task categories. The R&M model application within CHRT has been extended beyond the original design. For example, the specific data output element, "SE use hours/flightline," is not an output of the documented R&M model. This was a modification developed under the CHRT study to improve assessment capability.

In addition, the original R&M model was used only for unscheduled maintenance. Because significant resources are also required for scheduled maintenance, a technique has been devised to extend R&M model application to scheduled maintenance. This capability has been demonstrated and is described as follows. (The reader may wish to refer to Figure 4 during this description.) Scheduled maintenance networks may be prepared for any LRU in a subsystem and established in the appropriate data file. The scheduled maintenance tasks are set up support equipment, flightline troubleshooting (or more appropriately, checkout), removal of the LRU and replacement with a spare, verification of the removal and replacement, and shop retest-OK (the scheduled shop maintenance task). The probabilities of each of these tasks is 1; all other task probabilities are zero. For scheduled maintenance on the flightline, the set up support equipment task, and the cannot duplicate task (the scheduled maintenance task) are given a probability of 1; and all others are zero. Appropriate times and skills are then assigned to each task. The period of scheduled maintenance is applied in terms of mean flight-hours between maintenance actions. When scheduled maintenance is performed on a calendar basis, the period must be converted to flight-hours. To differentiate between scheduled and unscheduled maintenance requirements in the assessment, the letter "S" is inserted in the LRU code symbol. When failure data due to scheduled maintenance are available, they may also be included in the scheduled maintenance networks if the task probabilities are adjusted.

The R&M model has been extended to provide an early indication of training and technical manual information content requirements. Initially, the R&M program is modified to determine and order two data sets.

By Subsystem - Flightline (troubleshooting and non-troubleshooting)

1. Number of actions/KFH
2. Crew size
3. MMH/KFH

By LRU - Shop

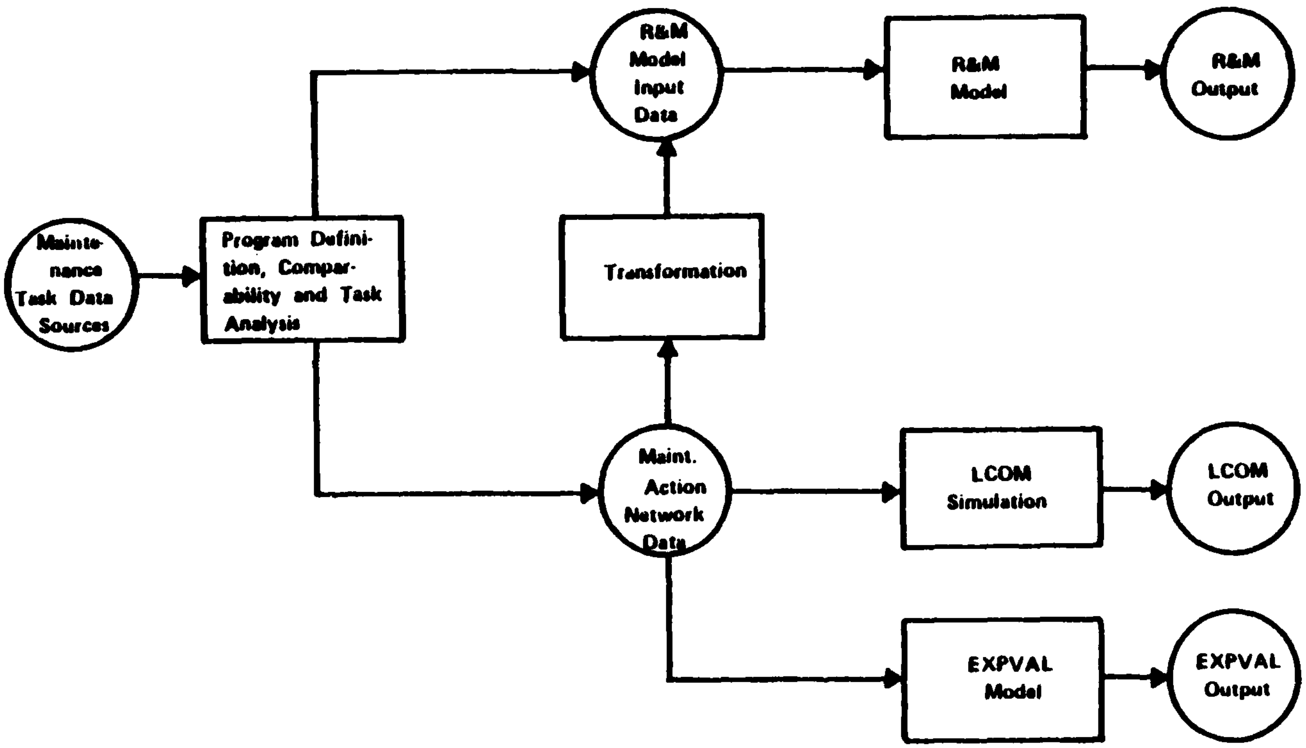
1. Number of actions/KFH
2. Crew size
3. MMH/KFH
4. Conditional mean task line

This output is then used as an input to an interactive training/aiding program. The latter program operates on these two data sets to determine and present the training/aiding matrix.

### 6.2.4 Description of Model Interrelationships

The interrelationship of LCOM, the expected value model, and the R&M model is depicted in Figure 12. In this figure, the circles represent data and the blocks represent various types of operations. Starting from left to right in the figure, external data sources are reviewed for maintenance task data by the program definition, comparability, and task analysis activity. The purpose in this case is to preprare R&M model input data or maintenance action network data, depending on which one of the three models is to be used. The former is required to support the R&M model while the latter is required to support LCOM and the expected value model.

Figure 12  R&M MODEL, LCOM, AND EXPVAL MODEL INTERRALATIONSHIP



To exploit the individual advantages of these models, all have been retained within CHRT. To do this efficiently, compatibility among the models was improved and minimization of input data was achieved. Before further discussion, however, some basic characteristics of the models will be reviewed (particularly of LCOM and the R&M model).

In LCOM, a Monte Carlo simulation, the maintenance action networks need not adhere to any specific predefined form. They must simply obey a set of rules for construction of a network of any size or complexity. It is well within these rules to describe a network for a complex subsystem as a single task and to simultaneously describe the repair process of a shop replaceable unit to the most intricate detail of parallel and consecutive tasks. In the normal application, however, the complexity of the network reflects the availability of data and interest in the equipments. LCOM is normally used where a system configuration is firmly established, where the operational scenario is known, and where the dynamics of the personnel and support equipment requirements are required to be known.

On the other hand, the R&M model is disciplined to a generalized or compressed maintenance action network consisting of seven flightline and three shop tasks. The concept for a generalized or compressed maintenance action network, as one which contained only the tasks handled by the R&M model, was discussed in Section 3.4.2. Complex networks are formed when the compressed networks are extended, as they are in LCOM, to include additional tasks, parallel tasks, and tasks with multiple records (such as the same task with different task characteristics). In addition, the R&M model is an average value model and, as such, considers only a generalized average value operational scenario. As a result, the output does not reflect the dynamics of the personnel and support requirements. The R&M model, however, is simpler to use and requires less resources to operate. It is very appropriate in the earlier phases of acquistion where many iterations are desired and where the accuracy of the input data does not justify use of the more complex method.

To increase the compatibility between the R&M model and LCOM and to maintain the simplest possible data base, a prototype preprocessor was developed. This program, KONVERT, converts a generalized maintenance action network data file to R&M model input data, eliminating the need to carry the R&M model data file in the CDB when both models are planned to be used. As the networks become more complex, however, they must be reduced manually to the generalized format before they can be operated on by the preprocessor. The block listed as transformation in

Figure 12, consists of this two-step process: the reduction of complex networks to generalized networks and the conversion of the maintenance action network data representing these generalized networks to R&M model input format.

As implemented by CHRT and employed in the acquistiion process, the R&M model is used very early and precedes application of LCOM. The basic reason is that data accuracy is limited and relative results among many alternatives are of primary interest, rather than the absolute assessment of a single or very few alternatives. The input data during the early phase is limited to generalized maintenance action networks retained in the maintenance action network data file, and the KONVERT preprocessor is employed. In this way, the option to use LCOM is not lost. In addition, the maintenance networks can readily be extended to the more complex form as the number of alternatives decrease and data accuracy and availability increases. At this point, a decision must be made to retain only the one file and use the two-step conversion when an R&M run is required or to establish a secondary R&M model input file. When only the R&M model is to be used, all data may be retained in R&M format. The reader should recognize also that an R&M input file is required for cost assessment with RMCM.

All three models conceivably would be established in the late design stage and retained throughout the remainder of the weapon system life cycle. The R&M model would be used as an integral part of CHRT in all phases, including production/deployment, to evaluate the impact of alternatives and changes. Used in conjunction with the RMCM, it would also be useful in identifying areas of high resource consumption or excessive ownership cost. LCOM would be retained to model the existing and potential maintenance systems and to dynamically evaluate their effectiveness in various scenarios. The expected value model would be used to provide a quick look at LCOM. This intermodel compatibility also exists in cases (many present weapon systems) where LCOM networks have been developed and have preceded R&M model development. The Extended Form 11 data can be converted to R&M model input data, and all advantages of RMCM can be obtained. The reader should be aware that a cost model is under development also for use with LCOM.

### 6.2.5 Operations/Support Assessment

The models discussed in the previous subsection traditionally have been used to provide assessments of flightline and shop prime equipment maintenance personnel requirements only. To completely assess the impact of a weapon system on personnel requirements, however, operations and other support personnel also must be considered. This type of assessment is accomplished in the CHRT process. The techniques used to perform this assessment are discussed in the following paragraphs.

An operations manpower assessment is accomplished using a simple calculation which is entirely satisfactory. Information regarding aircraft inventory characteristics (such as buldup, steady-state, and phase-down), aircraft/crew ratio, number and type of crewmembers per crew, and training aircraft/instructor crew ratio is obtained from the appropriate files in the program requirements and operations requirements/tasks data groups. Operator and instructor requirements then are calculated and presented on a fiscal year basis. The resulting information then is stored in the operations manpower estimates data file, part of the operations/support estimates data group.

Two specific areas in the support maintenance category are considered by CHRT because they have significant impact on both manpower requirements and SOC. These are support equipment operator/maintenance personnel and software support personnel. Estimates covering these areas are retained in the support maintenance manpower estimates data file of the operations/support estimates data group.

Support equipment operator/maintenance personnel primarily have an impact on personnel requirements at the base level where the majority of support equipment is used. Basic techniques for assessing this personnel area with LCOM and the R&M model have been developed during this study. The R&M model can be used to provide estimates of operator personnel for flightline support equipment and of operator/maintenance personnel for shop support equipment. The R&M model does not yet handle support equipment maintenance action networks and, as a result, cannot be used to estimate maintenance personnel requirements for flightline support equipment. Application of both the LCOM and the R&M model to support equipment operator/maintenance personnel has been limited to this study, and further application is needed.

The software support personnel factor is becoming increasingly important in support maintenance at the depot level due to the profusion of avionics and flight control software. These personnel are not directly considered by any of the five technologies. SOC and the RMCM models consider these personnel indirectly in that software support personnel drive the nonrecurring and recurring cost of software. Even here, however, existing techniques do not specifically quantify software support personnel requirements. Existing techniques rely on simple relationship factors such as: 15 work-months of effort is required per 1000 computer words when programming in assembly language. This factor, number of work (man) months per thousand words of code (NMMKW) is used in the software cost equations which are part of the RMCM. The basic information, required computer words, must first be estimated and established in the software configuration/characteristics data file (see Section 4.3.2.2 and Table 6). The factors then must be estimated or obtained from some source, usually a literature search or survey. The factors also must be appropriate for the situation. For example, although 15 work months per 1000 computer words for assembly language programming might be valid, it would not be appropriate if the programming were done in higher order language. Existing techniques, therefore, are based on expert opinion and judgement. Hopefully, future work will develop more commonly usable procedures.

### 6.2.6 Training Requirement Assessment

Training requirement assessment, as used here, is the determination of the type and duration of required training courses. It does not deal with the content of the courses or the facilities required to present the courses. The actual course requirement and the course duration are finally determined after the task analysis and training program development effort during the full-scale development and/or production phase. Until that time, an alternative method is required to estimate the training requirement, which is an important resource and cost factor. The types of training courses required are satisfactorily determined during early acquistiion from the support plan requirement and from knowledge of the skills and skill levels anticipated to operate and maintain the system. This inforamtion results from the program definition, comparability, and task analysis. The course length is determined using one of two techniques for operator and maintenance training, respectively. Both techniques use comparable course information as the base for estimating expected course duration.

### 6.2.7 Maintenance Training Requirements

Maintenance training courses include both specialty and technical training. Comparable courses of both types, when expected to be required, must be adjusted to the system design and support plan that will be implemented. Particular emphasis must be placed on adjusting the comparable course characteristics for compatibility with the personnel, training, and technical manual approach planned. Two specific integrated approaches have been considered during this study, the conventional (deductive) and the task-oriented (directive). The technique used to estimate duration and general content for these approaches, however, may be extended to any other approach. The selected training approach is then complemented with a similar technical manual approach, both of which are specifically geared to the skill level of the expected user.

Air Force specialty training courses exist for most skill areas. These courses, their duration, and the course material normally reflect the conventional approach. Course content generally follows the outline shown in Table 20. The task-oriented training factors, shown in parentheses opposite the conventional course outline, are used to adjust conventional course length to task-oriented course length. These task-oriented training factors were developed by two behavioral scientists and are based on both a knowledge of the objectives oriented approach is estimated by multiplying the conventional course time required for the various topics by the factors shown in parentheses. For example, the task-oriented approach provides little theory because the deductive reasoning process is effectively replaced by direction. Therefore, the time allotted to "Basic Principles" is only 20 percent of that in a conventional course. On the other hand, use of directive material and test equipment is more heavily emphasized in a task-oriented course than in a conventional course; therefore, "Technical publications, paperwork" and "Test equipment" are more heavily emphasized in task-oriented training.

Technical training course length estimates must be made on a judgment basis by competent training personnel. These personnel must possess a knowledge of new and/or estimated tasks and understanding of the expected user, the type training desired (I, II, or III), and the training approach (conventional or task-oriented). This estimate is based largely on judgment. It is a valid approach, but one which must be implemented by qualified personnel. Within CHRT, this judgment is made with full knowledge of the system design and support planning objectives and in coordination with other specialists.

### 6.2.8 Operator Training Requirements

Operator (aircrew) training estimates are made in a manner similar to maintenance technical training estimates. Aircrew specialty training, such as basic pilot or navigation training,

Table 20 CONVENTIONAL/TASK-ORIENTED TRAINING RELATIONSHIP

| Conventional Course Outline | Task-Oriented Training Factor |
|---|---|
| A. Basic Principles | (0.20) |
| B. General Information, Fundamentals, and Administration | —— |
| 1. General | (0.95) |
| 2. Technical Publications, paperwork | (1.10) |
| 3. Maintenance procedures | (0.90) |
| C. Applied Principles | —— |
| 1. General | (0.75) |
| 2. Specific | (1.00) |
| 3. Test equipment | (1.20) |
| D. Equipment Related Features | (0.50) |
| 1. Subsystem/LRU | —— |
| 2. LRU component | —— |
| E. Maintenance Requirements and Equipment Performance | (0.50) |
| 1. Standards, checks, adjustments | —— |
| 2. Troubleshooting procedures/support equipment | —— |

is not a valid system ownership cost (SOC) area and is not considered. Aircrew transition training on the weapon system, however, is a SOC consideration and estimates must be made.

The operator training assessment is made using two data files. The first is the operator course material data file which provides comparable course data. The second is the operator tasks data file which provides operator task listings modified to integrate new tasks due to the new system, and to reallocate or eliminate tasks accomplished on the comparable system. Samples of these task listings were shown in Tables 15 and 16.

The AMST was a very good example of how this procedure is accomplished. The comparable system was the C-130 and the mission objectives and functions of the two aircraft were very similar. The AMST, however, eliminated both a flight engineer and a navigator; therefore, their functions had to be reallocated where they still existed and eliminated where the function was no longer required due to equipment changes. Many specific flight performance and navigation duties were eliminated due to improved equipment such as inertial navigation equipment. Those that remained had to be allocated to the pilot and copilot. Additionally, the STOL capability added new tasks to be accomplished by the pilot and copilot. The task listings reflected these perturbations, and training course estimates were adjusted to absorb them.

### 6.2.9 Technical Manual Assessment

A prototype computer-based technical manual assessment program is used to estimate the quantity and types of pages that will be required for both flight line and shop technical manuals. The program may be used to estimate either conventional or task-oriented manuals. The conventional manual contains significant theory and is of the general kind procured by the Air Force over the last 15 years. The task-oriented manual is a newer type which is directive in nature and is specified by MIL-M-83495. The actual determination of page quantity by page type is made by algorithms within the computer program. The algorithms also can specify the quantity of troubleshooting and non-troubleshooting pages. The possible page types and the kind of manual (conventional or task-oriented) in which each type of page would be found, are provided in Table 21.

The algorithms were developed using F-15 system technical manual data. The development is described in References 13 and 14. The major variables in each of the algorithms are number of

Table 21 PAGE TYPES FOR CONVENTIONAL (C) AND TASK-ORIENTED (T) MANUALS

| Page Type | TS | | NTS | |
|---|---|---|---|---|
| | F/L | Shop | F/L | Shop |
| narrative | C/T | C | C | C |
| half tone art | C | C | C | C |
| half tone explosion | | C | | C |
| electronic line art | C | C | | C |
| exploded line art | | C | | |
| fault isolation chart | T | | | |
| fault isolation schematic block | T | C | | |
| access line art | T | | | |
| fault isolation schematic flow | T | C | | |
| fault isolation schematic mech/hyd | T | C | | |
| job guide narrative | | | T | |
| job guide illustrations | | | T | |

subsystems, LRUs, and SRUs in a system; and, the types of maintenance actions required to support each subsystem, LRU, and SRU. Additionally, these algorithms are unique to an equipment category. For example, avionics and landing gear are technically dissimilar and require different algorithms. A flight instrument/control system and an avionics system are similar and would use the same algorithms. Two sets of algorithms have been prepared: one for electrical and another for mechanical/hydraulic systems. The user of the technical manual assessment program therefore must assure that the appropriate algorithm is used.

The algorithm developed to predict the content of a fault isolation manual to support the task-oriented approach to flightline troubleshooting is provided here as an example. This algorithm determines the number of maintenance actions, pictorials, and schematics as a function of the number of subsystems and LRUs. In this case,

# actions = 2 actions/subsystems + 2 actions/LRU
# pictorials = 2 pictorials/LRU
# schematics = 1 schematic/subsystem + 1 schematic/LRU

The total pages are then calculated as follows:

# pages 1 action page/action + 1/2 narrative page/LRU
+ 1 pictorial page/pictorial
# 2 schematic pages/subsystem + 1 schematic page/LRU.

In this type of manual, the following page type relationships are applicable:

action page = fault isolation chart
narrative page = narrative
pictorial page = access line art
subsystem schematic page = fault isolation schematic block
LRU schematic page = fault isolation schematic flow

The technical manual assessment program utilizes the hardware configuration/chracteristics data file as a direct input. The output of the assessment program comprises the technical manual estimates data group (ellipse 14).

## 6.2.10 Training and Technical Manual Information Content Assessment

The assessment of training and technical manual information content is typically accomplished during the mid to full-scale development phase. This is done directly through the program definition, comparability, and task analysis activity (block A) and results in the intermediate products data group (ellipse 16).

There are, however, certain advantages to assessing training and technical manual information content earlier during the acquisition program. Such an assessment could be used to

1. Prioritize the importance of training and technical manual coverage areas.
2. Develop training and technical and manual statements of work.
3. Alert training and technical manual specialists to the possibility of extraordinary product needs.
4. Identify areas for training/technical/support equipment trade-offs.

A technique has been developed to perform an early assessment for three very basic tasks. These tasks are troubleshoot on the flightline, nontroubleshoot on the flightline, and repair in the shop. The first two are considered at the subsystem level (for example, a radio set). The third is considered at the LRU level (for example, the radio set receiver).

The technique consists of two steps. First, the R&M model, modified to compute and numerically order several task-related characteristics, is run for all the subsystems within a major system (for example, avionics). The characteristics computed and ordered are

1. Conditional Mean Task Time (CMTT)
   This is the amount of time required to perform a task given there is a failure and the task is performed. Since the tasks previously described are combinations of the various maintenance events present in a maintenance action network, the CMTT is computed as an average time weighted by the relative frequency of each maintenance event within the task.

2. Maintenance Actions/KFH
   This is the total number of maintenance actions segregated into the three task categories described.

3. Crew Size
   The average crew sizes among the maintenance events forming each type of task.

4. The Ratio of the probability of Maintenance on the Aircraft to the probability of Remove and Replace (P M A/C)/P (R&R)
   This ratio is computed for use as a modifier to crew size.

These characteristics are then input to an interactive prototype computer program, the training/aiding matrix program, which provides a preliminary assessment of training and technical manual information content requirements. The training/aiding matrix provides an indication of the degree of coverage required and is discussed in some detail in the next section. Limited experience with the training/aiding matrix to date indicates that it can be used to achieve the advantages cited earlier in this subsection.

## 6.3 DATA OUTPUT OF THE RESOURCE ASSESSMENT ACTIVITY

The data output of the resource assessment activity consists of the data groups and associated data files listed below.

| LCOM Output | EXPVAL Output | R&M Output |
|---|---|---|
| Baseline(s) | Baseline(s) | Baseline(s) |
| Alternatives | Alternatives | Alternatives |

<u>Operations & Support Estimates</u>

Operations Manpower Estimates
Baseline(s)
Alternatives
Support Maintenance Manpower Estimates
Baseline(s)
Alternatives

Training Estimates

Maintenance Training Estimates
Baseline(s)
Alternatives
Operator Training Estimates
Baseline(s)
Alternatives

Technical Manual Estimates

Baseline(s)
Alternatives

Training/Aiding Matrix

Baseline(s)
Alternatives

Detailed descriptions of these data groups and files are provided in the subsections which follow.

### 6.3.1 LCOM Output Data Group

The LCOM output data group (ellipse 9) is the main output of the LCOM simulation program, the performance summary report (PSR). A separate data file is maintained for each baseline(s) and an alternative on which LCOM is used. The reports are maintained in the CDB as computer printouts. During each simulation run, operations, aircraft, personnel, and support equipment data are collected and processed to produce this report. A complete example of a PSR is provided in Table 22. The data presented are quite extensive. To simplify data review, a number of more specific reports may be obtained through the use of post-processor modules to the LCOM simulation program. These additional reports include the following.

1. PSR statistical graphs of each PSR result versus time.
2. Aircraft time line displays.
3. Manpower matrices of personnel requirements versus time of day for each step.
4. Analysis of parts/resource usage and availability.
5. Mission statistical summary analysis.
6. Support equipment usage data.

A detailed description of the LCOM products is presented in Reference 8.

## Table 22 LCOM OUTPUT DATA FILE - PROJECTED AMST LANDING GEAR DATA

RUN NUMBER RECOM          P E R F O R M A N C E     S U M M A R Y          PERIOD FROM 0. TO 180.0     LEVEL 2

| O P E R A T I O N S | TOTAL | AOFLT | OTHER |
|---|---|---|---|
| 1 NUMBER OF MISSIONS REQUESTED | 3121.00 | 3120.00 | 0. |
| 2 NUMBER ACCOMPLISHED | 3120.00 | 3120.00 | 0. |
| 3 PERCENT ACCOMPLISHED | 100.00 | 100.00 | 0. |
| 6 NUMBER OF SORTIES REQUESTED | 3120.00 | 3120.00 | 0. |
| 7 NUMBER ACCOMPLISHED | 3120.00 | 3120.00 | 0. |
| 8 PERCENT ACCOMPLISHED | 100.00 | 100.00 | 0. |
| 11 NUMBER OF WEATHER CANCELS | 0. | 0. | 0. |
| 12 NUMBER OF WEATHER DELAYS | 0. | 0. | 0. |
| 13 NUMBER OF ALERT REPLENISHMENT | 0. | 0. | 0. |
| 14 NUMBER OF ATTRITIONS | 0. | 0. | 0. |
| 15 NUMBER OF RAM REPAIRS | 0. | 0. | 0. |
| 16 NUMBER OF AIR ABORTS(TOTAL) | 0. | 0. | 0. |

| A I R C R A F T | TOTAL | AMST | OTHER |
|---|---|---|---|
| 13 NUMBER OF AIRCRAFT AUTH.(LOP) | 52.00 | 52.00 | 0. |
| 14 NUMBER OF AIRCRAFT-DAYS AVAIL | 9360.00 | 9360.00 | 0. |
| 15 PCT SORTIES(INCL ALERT) | 6.97 | 6.97 | 0. |
| 16 PCT UNSCHED MAINTENANCE | 3.16 | 3.16 | 0. |
| 17 PCT SCHED MAINTENANCE | 3.34 | 3.34 | 0. |
| 18 PCT NORS | 0. | 0. | 0. |
| 19 PCT MISSION WAIT STATUS | .10 | .10 | 0. |
| 20 PCT SERVICE + WAITING | 11.99 | 11.99 | 0. |
| 21 PCT OPERATIONALLY READY | 74.43 | 74.43 | 0. |
| 22 AVG. AC POST SORTIE TIME(HRS) | 11.27 | 11.27 | 0. |
| 23 AVG. NO. OF SORTIES/ A/C /DAY | .33 | .33 | 0. |
| 24 FLYING HOURS | 15650.69 | 15650.69 | 0. |
| 17 NUMBER OF FCF TASKS FLOWN | 0. | 0. | 0. |
| 18 AVG. AC PRESORTIE TIME(HRS) | 2.00 | 2.00 | 0. |

| P E R S O N N E L | TOTAL | 42330 | 42334 | 42350 | 42354 | 4313R | 4313W | 43131 | 4315R | 4315W | 43151 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 MANHOURS AVAILABLE (1301) | 11520.00 | 720.00 | 720.00 | 720.00 | 720.00 | 720.00 | 720.00 | 720.00 | 720.00 | 720.00 | 2160.00 |
| 28 PERCENT UTILIZATION | 4.33 | 7.16 | 4.86 | 10.26 | 12.68 | .01 | .94 | 5.31 | 3.33 | 1.26 | 6.75 |
| 29 MANHOURS USED (1331) | 499.07 | 51.55 | 34.83 | 73.90 | 91.33 | .04 | 6.79 | 38.25 | 23.99 | 9.06 | 145.82 |
| 30 PCT UNSCHED MAINT. OF STAT 29 | 89.36 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 63.58 |
| 31 PCT SCHED MAINT. OF STAT 29 | 10.64 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 36.42 |
| F1 PCT PRIME OF STAT 29 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| F2 PCT SUBSTITUTE OF STAT 29 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 33 NUMBER OF MEN DEMANDED | 30449.00 | 3354.00 | 2582.00 | 4749.00 | 5773.00 | 1.00 | 509.00 | 2364.00 | 1772.00 | 729.00 | 15392.00 |
| P3 NBR OF MEN DEMANDED POST SCAN | 30449.00 | 3354.00 | 2582.00 | 4749.00 | 5773.00 | 1.00 | 509.00 | 2364.00 | 1772.00 | 729.00 | 15392.00 |
| 34 % AVAIL BY ON. BAL. OF RES | 81.49 | 65.80 | 50.63 | 64.75 | 68.27 | 100.00 | 95.87 | 76.78 | 62.70 | 95.06 | 100.00 |
| 35 % AVAIL BY GEN SUBS OF RES | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 36 % AVAIL BY EXPEDITE PROC. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 37 % AVAIL BY PREEMPTION PROC. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 38 % DEMANDS NOT AVAIL FOR RES | 19.51 | 34.20 | 49.37 | 35.25 | 31.73 | 0. | 4.13 | 23.22 | 37.30 | 4.94 | 0. |
| 39 OVERTIME MANHOURS USED (1301) | 2.24 | .35 | .33 | .55 | .56 | 0. | 0. | .25 | .21 | 0. | 0. |
| 40 SIMULATED MH PER FLYING HOUR | 3.19 | .33 | .22 | .47 | .58 | .00 | .04 | .24 | .15 | .06 | .93 |

## Table 22 LCOM OUTPUT DATA FILE - PROJECTED AMST LANDING GEAR DATA (continued)

RUN NUMBER RALCOM     P E R F O R M A N C E   S U M M A R Y     PERIOD FROM 0. TO 180.0     LEVEL 2

| S U P P L Y | TOTAL | OTHERS | 13AA0 | 13AB0 | 13AC0 | 13AD0 | 13BAJ | 13BBJ | 13BC0 | 13CAJ | 13DA0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 54 TOT DOLLAR INVEST,(1,000)(LOP) | 3150.00 | 0. | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 |
| 55 FILL RATE PERCENT | 100.00 | 0. | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 56 NUMBER OF BACKORDER-DAYS | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 57 NUMBER OF UNITS DEMANDED | 1504.00 | 0. | 24.00 | 52.00 | 6.00 | 22.00 | 1.00 | 42.00 | 5.00 | 34.00 | 15.00 |
| 58 PCT OFF-THE-SHELF | 100.00 | 0. | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 59 PCT EXPEDITED REPAIR | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 60 PCT PRECAMPTION | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 61 PCT DEMANDS NOT SATIS. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 62 NUMBER OF CANNIBALIZATIONS | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 63 NO. ITEMS ON BACKORDER (EOP) | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

| S U P P L Y | TOTAL | 13DB0 | 13DC0 | 13EA0 | 13EB0 | 13FA0 | 13FB0 | 13GA0 | 13GAU | 13G3U | 13GD0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 54 TOT DOLLAR INVEST,(1000)(LOP) | 3150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 |
| 55 FILL RATE PERCENT | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 0. | 100.00 |
| 56 NUMBER OF BACKORDER-DAYS | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 57 NUMBER OF UNITS DEMANDED | 1504.00 | 400.00 | 40.00 | 14.00 | 55.00 | 1.00 | 2.00 | 2.00 | 215.00 | 0. | 206.00 |
| 58 PCT OFF-THE-SHELF | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 0. | 100.00 |
| 59 PCT EXPEDITED REPAIR | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 60 PCT PRECAMPTION | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 61 PCT DEMANDS NOT SATIS. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 62 NUMBER OF CANNIBALIZATIONS | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 63 NO. ITEMS ON BACKORDER (EOP) | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

| S U P P L Y | TOTAL | 13GCG | 13GEG | OTHER |
|---|---|---|---|---|
| 54 TOT DOLLAR INVEST,(1000)(LOP) | 3150.00 | 150.00 | 150.00 | 0. |
| 55 FILL RATE PERCENT | 100.00 | 100.00 | 100.00 | 0. |
| 56 NUMBER OF BACKORDER-DAYS | 0. | 0. | 0. | 0. |
| 57 NUMBER OF UNITS DEMANDED | 1504.00 | 216.00 | 98.00 | 0. |
| 58 PCT OFF-THE-SHELF | 100.00 | 100.00 | 100.00 | 0. |
| 59 PCT EXPEDITED REPAIR | 0. | 0. | 0. | 0. |
| 60 PCT PRECAMPTION | 0. | 0. | 0. | 0. |
| 61 PCT DEMANDS NOT SATIS. | 0. | 0. | 0. | 0. |
| 62 NUMBER OF CANNIBALIZATIONS | 0. | 0. | 0. | 0. |
| 63 NO. ITEMS ON BACKORDER (EOP) | 0. | 0. | 0. | 0. |

RUN NUMBER PALCOM     P E R F O R M A N C E   S U M M A R Y     PERIOD FROM 0. TO 180.0     LEVEL 2

| E Q U I P M E N T | TOTAL | AJ35T | D62 | HC3 | H27H | HF2 | TJ30E | TJ35N | OTHER |
|---|---|---|---|---|---|---|---|---|---|
| 68 TOT DOLLAR INVEST,(1000)(LOP) | 1800.00 | 180.00 | 600.00 | 140.00 | 100.00 | 300.00 | 240.00 | 120.00 | 0. |
| 69 EQUIPMENT HOURS AUTH. (100) | 3456.00 | 216.00 | 1296.00 | 302.40 | 216.00 | 648.00 | 518.40 | 259.20 | 0. |
| 70 EQUIPMENT HOURS AVAIL. (100) | 3456.00 | 216.00 | 1296.00 | 302.40 | 216.00 | 648.00 | 518.40 | 259.20 | 0. |
| 71 PCT USED-UNSCHED MAINT | 6.10 | 8.33 | 7.15 | 1.42 | 3.88 | 5.74 | 6.46 | 6.46 | 0. |
| 72 PCT USED-SCHED MAINT | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 73 PCT UNUSED | 93.90 | 91.67 | 92.85 | 98.58 | 96.12 | 94.26 | 93.54 | 93.54 | 0. |
| 74 NUMBER OF BACKORDER-DAYS | 72.40 | 20.99 | 0. | 0. | 0. | 0. | 34.20 | 17.14 | 0. |
| 75 NUMBER OF UNITS DEMANDED | 14973.60 | 1004.00 | 6031.90 | 314.00 | 617.00 | 2105.00 | 2460.00 | 1234.00 | 0. |
| 76 PCT AVAILABLE | 99.02 | 97.51 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 0. |
| 77 PCT PROV. BY EXPEDITE | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 78 PCT PROV. BY RECLAMATION | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 79 PCT DEMANDS NOT SATIS. | .10 | 2.49 | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 80 EQUIP HOURS BACKLOG(100)(LOP) | .25 | .01 | .14 | 0. | .01 | .06 | .03 | .01 | 0. |

## Table 22 LCOM OUTPUT DATA FILE - PROJECTED AMST LANDING GEAR DATA (continued)

RUN NUMBER NHLCOH P E R F O R M A N C E S U M M A R Y PERIOD FROM 0. TO 100.0 LEVEL 2

| P E R S O N N E L | TOTAL | 53135 | 53156 | 53154 | 53155 | OTHER |
|---|---|---|---|---|---|---|
| 27 MANHOURS AVAILABLE (100) | 11520.00 | 720.00 | 720.00 | 720.00 | 720.00 | 0. |
| 28 PERCENT UTILIZATION | 4.33 | .00 | .07 | 1.59 | 1.60 | 0. |
| 29 MANHOURS USED (100) | 499.07 | .02 | .52 | 11.47 | 11.49 | 0. |
| 30 PCT UNSCHED MAINT. OF STAT 29 | 89.36 | 100.00 | 100.00 | 100.00 | 100.00 | 0. |
| 31 PCT SCHED MAINT. OF STAT 29 | 10.64 | 0. | 0. | 0. | 0. | 0. |
| P1 PCT PRIME OF STAT 29 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 0. |
| P2 PCT SUBSTITUTE OF STAT 29 | 0. | 0. | 0. | 0. | 0. | 0. |
| 33 NUMBER OF MEN DEMANDED | 38449.00 | 2.00 | 22.00 | 599.00 | 601.00 | 0. |
| P3 NBR OF MEN DEMANDED FIRST SCAN | 38449.00 | 2.00 | 22.00 | 599.00 | 601.00 | 0. |
| 34 % AVAIL BY OH. BAL. OF RES | 80.49 | 100.00 | 90.91 | 95.99 | 96.01 | 0. |
| 35 % AVAIL BY GEN SUBS OF RES | 0. | 0. | 0. | 0. | 0. | 0. |
| 36 % AVAIL BY EXPEDITE PROC. | 0. | 0. | 0. | 0. | 0. | 0. |
| 37 % AVAIL BY PREEMPTION PROC. | 0. | 0. | 0. | 0. | 0. | 0. |
| 38 % DEMANDS NOT AVAIL FOR RES | 19.51 | 0. | 9.09 | 4.01 | 3.99 | 0. |
| 39 OVERTIME MANHOURS USED (100) | 2.24 | 0. | 0. | 0. | 0. | 0. |
| 40 SIMULATED MH PER FLYING HOUR | 3.19 | .00 | .00 | .07 | .07 | 0. |

| S H O P R E P A I R | TOTAL | OTHERS | 13AA0 | 13AB0 | 13AC0 | 13AD0 | 13BA0 | 13BB0 | 13BC0 | 13CA0 | 13DA0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 NO. OF REPARABLE GENERATIONS | 1504.00 | 0. | 24.00 | 52.00 | 6.00 | 22.00 | 1.00 | 42.00 | 5.00 | 34.00 | 15.00 |
| 45 PCT BASE REPAIR | 100.00 | 0. | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 46 PCT DEPOT REPAIR | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 47 AVERAGE BASE REPAIR CYCLE | .19 | 0. | .29 | .40 | .06 | .11 | .10 | .54 | .13 | .30 | .05 |
| 48 PCT ACTIVE REPAIR | 100.00 | 0. | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 49 PCT WHITE SPACE | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | .00 | 0. |
| 50 NO. OF ITEMS IN REPAIR (EOP) | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 51 NO. OF ITEMS BACKLOGGED (EOP) | 2.00 | 0. | 0. | 0. | 0. | 0. | 0. | 1.00 | 0. | 0. | 0. |

| S H O P R E P A I R | TOTAL | 13DB0 | 13DC0 | 13EA0 | 13EB0 | 13FA0 | 13FB0 | 13GAB | 13GA0 | 13GBB | 13GB0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 NO. OF REPARABLE GENERATIONS | 1504.00 | 460.00 | 48.00 | 14.00 | 55.00 | 1.00 | 2.00 | 2.00 | 215.00 | 0. | 208.00 |
| 45 PCT BASE REPAIR | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 0. | 100.00 |
| 46 PCT DEPOT REPAIR | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 47 AVERAGE BASE REPAIR CYCLE | .15 | .15 | .01 | .08 | .20 | .01 | .00 | .00 | .10 | 0. | .14 |
| 48 PCT ACTIVE REPAIR | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 0. | 100.00 |
| 49 PCT WHITE SPACE | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 50 NO. OF ITEMS IN REPAIR (EOP) | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 51 NO. OF ITEMS BACKLOGGED (EOP) | 2.00 | 1.00 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

| S H O P R E P A I R | TOTAL | 13GD0 | 13GE0 | OTHER |
|---|---|---|---|---|
| 44 NO. OF REPARABLE GENERATIONS | 1504.00 | 216.00 | 93.00 | 0. |
| 45 PCT BASE REPAIR | 100.00 | 100.00 | 100.00 | 0. |
| 46 PCT DEPOT REPAIR | 0. | 0. | 0. | 0. |
| 47 AVERAGE BASE REPAIR CYCLE | .19 | .13 | .12 | 0. |
| 48 PCT ACTIVE REPAIR | 100.00 | 100.00 | 100.00 | 0. |
| 49 PCT WHITE SPACE | 0. | 0. | 0. | 0. |
| 50 NO. OF ITEMS IN REPAIR (EOP) | 0. | 0. | 0. | 0. |
| 51 NO. OF ITEMS BACKLOGGED (EOP) | 2.00 | 0. | 0. | 0. |

### 6.3.2 EXPVAL Output Data Group

The EXPVAL output data group (ellipse 10) is the product of the expected value model program. A separate EXPVAL output data file is maintained for each baseline and alternative on which the expected value model is run. The output is retained in the CDB as a computer printout. The expected value output represents a summation of Extended Form 11 resource data categorized as follows.

By support equipment (SE) item:

1. SE use hours/on-equipment
2. SE use hours/off-equipment

By AFSC and skill level:

1. MMH/on-equipment
2. MMH/off-equipment

Additional information regarding the EXPVAL model and output may be found in References 19 and 20.

### 6.3.3 R&M Output Data Group

The R&M output data group (ellipse 11) is the product of the R&M model program. A separate data file is maintained for each baseline(s) and alternative on which the R&M model is run. The output is retained in the CDB as a computer printout.

The term "R&M model" as used here applies to the R&M model documented by Reference 21 and as enhanced by complementary prototype programs developed as part of this study. These enhancements have been discussed in Section 6.2. The specific categories and output sets of data available from the R&M model are the following:

By subsystem

1. Availability
2. MMH/task
3. MTTR/task

4. MFHBMA
5. SE use hours/flightline
6. SE use hours/shop
7. SE repair time/shop

By LRU and task

1. MMH/KFH
2. MMH
3. MTTR by AFSC (skill and level)/LRU and subsystem
4. MMH/KFH
5. Cost/KFH

By subsystem - flightline (troubleshooting and non-troubleshooting)

1. Number of actions/KFH
2. Crew size
3. MMH/KFH

By LRU - shop

1. Number of actions/KFH
2. Crew size
3. MMH/KFH
4. Conditional mean task line

The latter two are used as input sets to the training/aiding matrix program.

A complete R&M output data file is provided in Table 23. The sample represents the R&M output for the standard station keeping equipment. It was developed by application of the R&M model to the R&M model data file provided in Table 12.

### 6.3.4 Operations/Support Estimates Data Group

At the present time, the operations/support estimates data group (ellipse 12) consists of two data files. These are the operations manpower estimates data file and the support manpower estimates data file. Within each file estimates are retained for each baseline and alternative considered. All of these data files are retained in the CDB as hard copy.

Table 23 R&M DATA OUTPUT - STANDARD STATION KEEPING EQUIPMENT

AMST STATION KEEPING EQUIPMENT R&M DATA – STANDARD

AFSC-32831 $ 1.00

| | MMH/KFH | COST/KFH |
|---|---|---|
| DAN252 | 14.34791 | 14.34791 |
| DAN253 | 33.81217 | 33.81217 |
| DAN254 | 0.31939 | 0.31939 |
| FL | 56.47148 | 56.47148 |
| DAN250 | 104.95096 | 104.95096 |
| FL | 3.84615 | 3.84615 |
| DAN250 | 3.84615 | 3.84615 |
| TOTAL | 108.79711 | 108.79711 |

AFSC-32851 $ 1.00

| | MMH/KFH | COST/KFH |
|---|---|---|
| DAN251 | 2.97719 | 2.97719 |
| DAN252 | 26.32015 | 26.32015 |
| DAN253 | 40.22243 | 40.22243 |
| DAN254 | 0.57490 | 0.57490 |
| DAN255 | 0.00684 | 0.00684 |
| DAN256 | 0.33232 | 0.33232 |
| DAN257 | 0.00684 | 0.00684 |
| FL | 113.50571 | 113.50571 |
| DAN250 | 183.94639 | 183.94639 |
| DAN2S3 | 32.05128 | 32.05128 |
| FL | 0. | 0. |
| DAN2S0 | 32.05128 | 32.05128 |
| TOTAL | 215.99767 | 215.99767 |

AFSC-53153 $ 1.00

| | MMH/KFH | COST/KFH |
|---|---|---|
| FL | 8.41066 | 8.41066 |
| DAN250 | 8.41066 | 8.41066 |
| TOTAL | 8.41066 | 8.41066 |

Table 23 R&M DATA OUPUT - STANDARD STATION KEEPING EQUIPMENT (continued)

AMST STATION KEEPING EQUIPMENT R&M DATA – STANDARD

SUBSYSTEM INHERENT FLIGHTLINE AVAILABILITY

| Subsystem | Availability |
|---|---|
| DAN250 | 0.8981 |
| DAN250 | 0.9962 |

Service Flightline Availability – 0.8946

MTTR FOR ALL SUBSYSTEMS AMST STATION KEEPING' EQUIPMENT R&M DATA – STANDARD

| Subsy | AGE F/L | TS F/L | R&R | VR&R | CND A/C | M A/C | FM A/C | Shop | Tot/Out |
|---|---|---|---|---|---|---|---|---|---|
| DAN250 | 0. | 1.18500 | 1.26400 | 0. | 0.31500 | 0.22120 | 0. | 1.85259 | 4.83779 |
| DAN250 | 0. | 0.10000 | 0.20000 | 0. | 0. | 0. | 0. | 2.50000 | 2.80000 |
| TOTAL | 0. | 1.28500 | 1.46400 | 0. | 0.31500 | 0.22120 | 0. | 4.35259 | 7.63779 |

MMH FOR ALL SUBSYSTEMS AMST STATION KEEPING EQUIPMENT R&M DATA – STANDARD

| Subsy | AGE F/L | TS F/L | R&R | VR&R | CND A/C | M A/C | FM A/C | Shop | Tot/Out |
|---|---|---|---|---|---|---|---|---|---|
| DAN250 | 0. | 1.1850 | 2.5280 | 0. | 0.3150 | 0.6636 | 0. | 3.1276 | 7.8192 |
| DAN250 | 0. | 0.1000 | 0.2000 | 0. | 0. | 0. | 0. | 2.5000 | 2.8000 |
| TOTAL | 0. | 1.2850 | 2.7280 | 0. | 0.3150 | 0.6636 | 0. | 5.6276 | 10.6192 |

## Table 23 R&M DATA OUTPUT - STANDARD STATION KEEPING EQUIPMENT (concluded)

R&M PER 1000 FH — AWST STATION KEEPING EQUIPMENT R&M DATA - STANDARD

SUBSYSTEM-OAN250 (72L00) S.K.E. UNSCHEDULED MAINTENANCE — MFHBMA 26.3

| | AGE F/L | TS F/L | R+R | VR+R | CND A/C | R A/C | VM A/C | SHOP | TOT/OUT |
|---|---|---|---|---|---|---|---|---|---|
| LRU-OAN251 (72LA0) RADAR & ANTENNA ASSEMBLY | | | | | | | | | |
| W | 0. | 0.496 | 1.323 | 0. | | | | 0.992 | 2.812 |
| E | 0. | 0. | 0. | 0. | | | | 0. | 0. |
| M | 0. | 1.489 | 3.970 | 0. | | | | 1.985 | 7.443 |
| SUB | 0. | 1.985 | 5.293 | 0. | | | | 2.977 | 10.255 |
| LRU-OAN252 (72LC0) RECEIVER/TRANSMITTER | | | | | | | | | |
| W | 0. | 5.687 | 15.148 | 0. | | | | 26.510 | 47.358 |
| E | 0. | 0.715 | 1.901 | 0. | | | | 2.186 | 4.800 |
| M | 0. | 7.808 | 20.821 | 0. | | | | 11.972 | 40.602 |
| SUB | 0. | 14.202 | 37.871 | 0. | | | | 40.668 | 92.740 |
| LRU-OAN253 (72LB0) CODER/DECODER | | | | | | | | | |
| W | 0. | 13.865 | 36.973 | 0. | | | | 64.703 | 115.542 |
| E | 0. | 0.952 | 2.540 | 0. | | | | 2.921 | 6.413 |
| M | 0. | 4.181 | 11.148 | 0. | | | | 6.410 | 21.739 |
| SUB | 0. | 18.998 | 50.662 | 0. | | | | 74.035 | 143.694 |
| LRU-OAN254 (72LAE) ELECTRONIC MOUNT | | | | | | | | | |
| W | 0. | 0.200 | 0.532 | 0. | | | | 0.586 | 1.317 |
| E | 0. | 0.029 | 0.076 | 0. | | | | 0.053 | 0.158 |
| M | 0. | 0.274 | 0.730 | 0. | | | | 0.256 | 1.259 |
| SUB | 0. | 0.502 | 1.338 | 0. | | | | 0.894 | 2.735 |
| LRU-OAN255 (72LS0) SIGNAL DATA CONVERTER | | | | | | | | | |
| W | 0. | 0. | 0. | 0. | | | | 0. | 0. |
| E | 0. | 0. | 0. | 0. | | | | 0. | 0. |
| M | 0. | 0.034 | 0.091 | 0. | | | | 0.007 | 0.132 |
| SUB | 0. | 0.034 | 0.091 | 0. | | | | 0.007 | 0.132 |
| LRU-OAN256 (72LFG) INDICATOR COUPLER | | | | | | | | | |
| W | 0. | 0.116 | 0.306 | 0. | | | | 0.167 | 0.588 |
| E | 0. | 0.017 | 0.046 | 0. | | | | 0.016 | 0.079 |
| M | 0. | 0.160 | 0.426 | 0. | | | | 0.149 | 0.735 |
| SUB | 0. | 0.293 | 0.778 | 0. | | | | 0.332 | 1.399 |
| LRU-OAN257 (72LAM) AUDIO AMPLIFIER | | | | | | | | | |
| W | 0. | 0. | 0. | 0. | | | | 0. | 0. |
| E | 0. | 0. | 0. | 0. | | | | 0. | 0. |
| M | 0. | 0.034 | 0.091 | 0. | | | | 0.007 | 0.132 |
| SUB | 0. | 0.034 | 0.091 | 0. | | | | 0.007 | 0.132 |
| CND | 0. | | | | 11.977 | | | | 11.977 |
| R | 0. | 9.311 | | | | 25.232 | 0. | | 34.543 |
| TOT/TSE | 0. | 45.357 | 96.122 | 0. | 11.977 | 25.232 | 0. | 118.920 | 297.308 |

SUBSYSTEM-OAN250 (72L00) S.K.E. SCHEDULED MAINTENANCE — MFHBMA 75.3

| | AGE F/L | TS F/L | R+R | VR+R | CND A/C | R A/C | VM A/C | SHOP | TOT/OUT |
|---|---|---|---|---|---|---|---|---|---|
| LRU-OAN253 (72LB0) CODER/DECODER (SCHEDULED MAINTENANCE) | | | | | | | | | |
| W | 0. | 0. | 0. | 0. | | | | 0. | 0. |
| E | 0. | 1.2821 | 2.5641 | 0. | | | | 32.0513 | 35.8976 |
| M | 0. | 0. | 0. | 0. | | | | 0. | 0. |
| SUB | 0. | 1.2821 | 2.5641 | 0. | | | | 32.0513 | 35.8976 |
| CND | 0. | | | | 0. | | | | 0. |
| R | 0. | 0. | | | | 0. | 0. | | 0. |
| TOT/TSE | 0. | 1.2821 | 2.5641 | 0. | 0. | 0. | 0. | 32.0513 | 35.8976 |

### 6.3.4.1 Operations Manpower Estimates Data File

Operations manpower estimates are made and a data file is established for each operations manning alternative which is addressed. Operations manpower estimates are derived through a manual procedure which considers the number of aircraft available, the number of crews required per aircraft, and the number and type of crewmembers per crew. Calcualtions are made for both operator and instructor personnel. These calcualtions are presented in a schedule format which addresses crews to be trained and total operator and instructor crew requirements on a fiscal year basis. A sample operations estimate is presented in Table 24.

### 6.3.4.2 Support Maintenance Manpower Estimates Data File

The support maintenance manpower data file is reserved for estimates of support equipment personnel and software maintenance personnel. The LCOM and R&M model address hardware maintenance personnel and, to a limited degree, support equipment maintenance personnel. Software support personnel are not addrassed by these models.

## 6.3.5 Training Estimates Data Group

The training estimate data group (ellipse 13) consists of two data files: the maintenance training estimate data file and the operator training estimate data file. Each file is developed through manual but distinctly different processes. Both files are similar, however, in that they provide estimates of training course length and are stored in the CDB as hard copy.

### 6.3.5.1 Maintenance Training Estimate Data File

Maintenance training estimates are developed from data maintained in the maintenance training course material data file (Section 4.3.4.4) for the AFSC and skill levels required. In the case of specialty training, standard course lengths are used if a conventional approach to training is planned. Standard course lengths may be modified using a set of established guidelines to

Table 24 OPERATION MANPOWER ESTIMATE

| 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90-02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Crews to be Trained | | | | | | | | |
| 8 | 32 | 84 | 132 | 136 | 156 | 119 | 54 | 54 | 54 | 0 | 0 | 0 | 0 | 0 |
| | | | | Total Operations and Instructor Crews Required | | | | | | | | | | |
| 8 | 40 | 120 | 240 | 352 | 472 | 544 | 544 | 540 | 508 | 432 | 312 | 192 | 72 | 0 |

Crew Composition

Pilot

Copilot

Navigator*

Loadmaster

BASIC REQUIREMENT

2-Crews/Aircraft

256—Unit Equipped Aircraft Peak

16—Training Aircraft Peak

TRAINING REQUIREMENT DERIVATION

FY83-89 New Crew Requirement + 10% Turnover

FY90-04 10% Turnover

FY05-09 10% Turnover Satisfied by Reassignment

*Four-man flight crew only

provide estimates of task-oriented training course length. A sample maintenance training estimate data file is presented in Table 25 for projected AMST AFSC and skill levels. Conventional and task-oriented course length estimates are provided.

### 6.3.5.2 Operator Training Estimate Data File

Operator training estimates are developed from data maintained in the operator tasks data file and operator course material data file (Sections 4.3.5.3 and 4.3.5.4). Table 26 presents the operator training estimate data file for the AMST. The "AMST Additional Training Estimate" indicates the number of days of training required beyond that of the reference C-130 training course. The training schedule indicates the number and type of training days estimated for the AMST.

### 6.3.6 Technical Manual Estimates Data Group

The technical manual estimates data group (ellipse 14) provides the estimated page type and quantity of pages for both troubleshooting (TS), and non-troubleshooting (NTS). Each of these categories is further subdivided into flightline and shop. A separate technical manual estimates data file should be maintained for each hardware baseline and alternative design. These files are retained in the CDB as hard copy computer printout. Sample technical manual estimates for the projected AMST landing gear are provided in Table 27. These estimates were derived using the prototype computer program described in Section 6.2.9.

### 6.3.7 Training/Aiding Matrix Data Group

The training/aiding matrix data group (ellipse 15) provides information content requirements in terms of the degree of coverage required in training and/or tech manuals for both flightline and shop tasks. The procedure used to develop this matrix was described in paragraph 6.2.10. The matrix is meant for use during the conceptual, validation, and early full scale development phases. A separate data file is established on each baseline and alternative, as appropriate, and stored in the CDB as a hard copy computer printout. A training/aiding matrix would normally be desired only for major system basleline(s) and alternatives.

A sample training/aiding matrix is provided in Table 28 for projected AMST landing gear with a task-oriented training and technical manual approach supported on the flightline by 3-skill-level personnel. The degree of information coverage for training and technical manuals appears as a ratio, but is not a mathematical term. It should be read as the training requirement versus the technical manual requirement. A 1 indicates light coverage required in either area while a 3 indicates heavy coverage, and 2 means average.

The potential applications of the training/aiding matrix are (a) to identify subsystems with heavy training/aiding requirements, (b) to assist in determination of special aiding and training devices, and (c) to assist in the prioritization of task analysis emphasis where financial or time constraints are factors. The training/aiding matrix eventually is replaced by the intermediate products of the integrated task analysis. These products, in addition to providing the basic data for training program and technical manual development, have these same potential applications.

Table 25

MAINTENANCE TRAINING ESTIMATE DATA FILE –
PROJECTED AMST AFSCs AND SKILL LEVELS

| AFSC | Title | Conventional | Task Oriented |
|---|---|---|---|
| 32850 | Avionics Comm | | |
| 32830 | | 28 wks | 13 wks |
| 32851 | Avionics Nav | | |
| 32831 | | 30 wks | 13 wks |
| 32854 | Avionics Inertial & | | |
| 32834 | Radar Nav | 27 wks | 15 wks |
| 42350 | Aircraft Electrical | | |
| 42330 | Systems | 19 wks | 11 wks |
| 42354 | Aircraft Pneudraulics | | |
| 42334 | | 11 wks | 8 wks |
| 43151 | Aircraft Maintenance | | |
| 43131 | | 11 wks | 8 wks |
| 53150 | Machinist | | |
| 53153 | Airframe Repair | | |
| 53133 | | 13 wks | 8 wks |
| 53154 | Corrosion Control | | |
| 53134 | | | |
| 53155 | Non-Destructive | 3 wks | 2 wks |
| 53135 | Inspection | 14 wks | 10 wks |

Table 26

AMST OPERATOR TRAINING ESTIMATE DATA FILE

AMST ADDITIONAL TRAINING ESTIMATE

| PHASE | SEGMENT | COURSE DAYS |
|---|---|---|
| Initial | | |
| | Classroom/Task Training | +2 |
| | Simulator | +2 |
| | Flying | +2 |
| | Written | – |
| Mission | | |
| | Classroom and Crew Procedure Timing | +3 |
| | Flying | +4 |
| | Written | – |

TRAINING SCHEDULE

| PHASE | SEGMENT | DURATION* |
|---|---|---|
| Initial | | |
| | Class Room | 14 |
| | Simulator | 16 |
| | Flying | 15 |
| | Written | 1 |
| | Travel | 3 |
| | | 49 days |
| Mission | | |
| | Class Room | 14 |
| | Flying | 28 |
| | Written | 1 |
| | | 43 days |

*Assumes 5 day week schedule and includes weekends.

Table 27 TECHNICAL MANUAL ESTIMATE DATA FILE - AMST

TECH MANUAL CONTENT ESTIMATE
MECH\HYDRO - CONVENTIONAL

| PAGE TYPE | TS | | NTS | |
|---|---|---|---|---|
| | F/L | SHOP | F/L | SHOP |
| NARRATIVE | 116 | 62 | 316 | 233 |
| HALF TONE ART | 11 | 93 | 11 | |
| HALF TONE EXPLOSION | 93 | | 93 | 11 |
| ELECTRONIC LINE ART | | | | 7 |
| EXPLODED LINE ART | | | | |
| FAULT ISOLATION CHART | | | | |
| FAULT ISOLATION SCHEMATIC BLOCK | | 21 | | |
| ACCESS LINE ART | | | | |
| FAULT ISOLATION SCHEMATIC FLOW | | | | 7 |
| FAULT ISOLATION SCHEMATIC MECH/HYD | | 21 | | |
| JOB GUIDE NARRATIVE | | | | |
| JOB GUIDE ILLUSTRATIONS | | | | |
| TOTALS | 219 | 197 | 419 | 257 |

SUBSYSTEMS 7.
LRU 21.
SRU 186.

TECH MANUAL CONTENT ESTIMATE
MECH\HYDRO - TASK ORIENTED

| PAGE TYPE | TS | | NTS | |
|---|---|---|---|---|
| | F/L | SHOP | F/L | SHOP |
| NARRATIVE | 93 | 62 | | 233 |
| HALF TONE ART | | 93 | | |
| HALF TONE EXPLOSION | | | | 11 |
| ELECTRONIC LINE ART | | | | 7 |
| EXPLODED LINE ART | | | | |
| FAULT ISOLATION CHART | 207 | | | |
| FAULT ISOLATION SCHEMATIC BLOCK | | 21 | | |
| ACCESS LINE ART | 186 | | | |
| FAULT ISOLATION SCHEMATIC FLOW | | | | 7 |
| FAULT ISOLATION SCHEMATIC MECH/HYD | | 21 | | |
| JOB GUIDE NARRATIVE | | | 1860 | |
| JOB GUIDE ILLUSTRATIONS | | | 1860 | |
| TOTALS | 486 | 197 | 3720 | 257 |

SUBSYSTEMS 7.
LRU 21.
SRU 186.

Table 28 TRAINING/AIDING MATRIX

AMST LANDING GEAR MED PHASE – TASK ORIENTED TRAINING & T.O. – 3 LEVEL

| | Flightline Nontroubleshoot | Flightline Troubleshoot | Shop Repair |
|---|---|---|---|
| * EQUIPMENT * | | | |
| GLG110 | 2/2 | 2/3 | |
| GLG111 | | | 2/2 |
| GLG112 | | | 2/2 |
| GLG113 | | | 2/2 |
| GLG114 | | | 2/2 |
| GLG120 | 2/2 | 2/3 | |
| GLG121 | | | 2/2 |
| GLG122 | | | 2/2 |
| GLG123 | | | 2/2 |
| GLG130 | 1/3 | 2/3 | |
| GLG131 | | | 2/2 |
| GLG140 | 3/1 | 3/3 | |
| GLG141 | | | 2/2 |
| GLG142 | | | 2/2 |
| GLG143 | | | 2/2 |
| GLG150 | 2/2 | 2/3 | |
| GLG151 | | | 2/2 |
| GLG152 | | | 2/2 |
| GLG160 | 2/2 | 1/3 | |
| GLG161 | | | 2/2 |
| GLG162 | | | 2/2 |
| GLG170 | 2/2 | 1/3 | |
| GLG171 | | | 2/2 |
| GLG172 | | | 2/2 |
| GLG173 | | | 2/2 |
| GLG174 | | | 2/2 |
| GLG175 | | | 2/2 |
| GLG176 | | | 2/2 |

## SECTION VII. LIFE CYCLE COST ASSESSMENT

### 7.1 OVERVIEW

The life cycle cost assessment activity (block D) is accomplished within CHRT by use of RMCM, an analytical cost accounting model capable of computing the LCC of a proposed weapon system (see Figure 13). Input data to the model are provided by data files of the system design data group (ellipse 3), the maintenance requirements and tasks data group (ellipse 5), and the cost/cost related data group (ellipse 8). Cost assessments are stored in the CDB as compute printouts in the LCC estimates data group (ellipse 17).

### 7.2 THE LCC ASSESSMENT ACTIVITY

At the present time, all CHRT LCC assessments are made using the RMCM. This model provides a structured and systematic way of aggregating the costs that make up an LCC estimate. These costs are calculated for development, production, operation, and support using a specific set of cost equations. The RMCM is composed of both the R&M model and a cost model. As such it is directly sensitive to system design and support planning alternatives that affect reliability or maintainability of the weapon system. Input data in the required format are directly provided by:

1. Hardware configuration/characteristics data file (Section 4.3.2.1).

2. R&M model data file (Section 4.3.4.3)

3. Cost/cost-related data file (Section 4.3.4.3)

A separate data file is required for each baseline or alternative under consideration.

The RMCM may be applied at the weapon system, major system, or subsystem level. Separate data files are prepared and computer runs made for each baseline and alternative. Data file preparation is a major activity for the first baseline.

## Figure 13 LIFE CYCLE COST ELEMENTS

- LCC - Life Cycle Cost
  - NRC Non-Recurring Cost
    - CRD -- Cost of Research & Development 1
    - CSI Cost of System Investment
      - CPP -- Cost of Procurement 2
      - CPM -- Cost of Project Management 3
    - COI Cost of Support Investment
      - CPTI -- Cost of Initial Maintenance Personnel Training 4
      - CSPI -- Cost of Spares Investment 5
      - CDRI -- Cost of Initial Depot Support Equipment 6
      - CSEI -- Cost of Base Level Support Equipment Investment 7
      - CSWI -- Cost of Software Acquisition 8
      - CJGI -- Cost of Initial Maintenance Manuals 9
      - CIMI -- Cost of Inventory Management Initial 10
      - CFAI -- Cost of New or Additional Facilities 11
  - RC Recurring Cost
    - CO Cost of Operation
      - COP -- Cost of Operations Personnel 12
      - CFL -- Cost of Fuel 13
    - CS Cost of Support
      - COM -- Cost of On-Equipment Maintenance 14
      - CSM -- Cost of Intermediate Shop Maintenance 15
      - CPT -- Cost of Maintenance Personnel Training 16
      - CSP -- Cost of Replacement Spares 17
      - CDR -- Cost of Depot Maintenance 18
      - CSE -- Cost of Maintaining Support Equipment 19
      - CSW -- Cost of Software Support
      - CJG -- Cost of Supporting Maintenance Manuals
      - CIM -- Cost of Inventory Management
  - CDP Cost of System Disposal

Experience indicates, however, that additional baseline and alternative data files are basically variations of the first baseline and that preparation of these files can be accomplished with much less effort. The fact that the cost model accepts input data at varying levels of detail allows its initial application early in acquisition and/or retrofit. It may then be updated in both detail and accuracy as more information becomes available. This approach provides continuity of methodology and assures traceability of results throughout the acquisition or life cycle of the system or modification. The RMCM provides a computer printout of 10 reports. These are listed in Section 7.3. Additionally, the RMCM has an interactive mode whereby the operator may insert various alternatives and receive an immediate response in terms of the impact of the alternative on some element of LCC. Because of this interactive capability and the fact that even the full computerized report requires so little resource expenditure, the RMCM is expedient to employ in early acquisition where many alternatives must be evaluated and where visibility to LCC is critical in identifying cost avoidance actions. The cost model is structured so that its outputs facilitate the identification of specific cost areas and their interrelationships.

The RMCM is programmed for and currently operational on the CDC-6600 computer at Wright-Patterson AFB, Ohio. Consequently, the FORTRAN programming language used by the model responds to the syntax of the CDC-6600 FORTRAM compiler. The interactive program is run on-line using the CDC INTERCOM time-sharing system. A remote terminal is required for use of this program. The batch print program uses the NOS/BE system and may be submitted by a remote terminal at the user's facility or by card deck at the computer facility.

Work is presently underway to adapt the cost portion of RMCM so that it may be driven by LCOM output. The initial interface between the two will be manual, but may be upgraded in the future. The advantage of such an advance is obvious. The dynamics of the operational scenario can now be considered when assessing LCC.

## 7.3 THE LCC ESTIMATE DATA GROUP

The LCC estimate data group (ellipse 17) consists of a data file for each baseline and alternative assessed, and consists of the RMCM output. This output is retained in the CDB as a computer printout. Each LCC estimate is presented in a series of 10 reports. These are:

Availability by Subsystem

Report No. 1 - System Cost
Report No. 2 - Expanded Nonrecurring Costs
Report No. 3 - Expanded Recurring Costs
Report No. 4 - Costs by Subsystem Contributions
Report No. 5 - Cost by LRU Contributions
Report No. 6 - Reliability, Maintainability, and Availability by Subsystem
Report No. 7 - Man-Hour Costs/Year by AFSCs and Subsystem Supported
Report No. 8A - Spares Requirements - Investment
Report No. 8B - Spares Requirements/Year - Replacement
Report No. 9 - Support Equipment Requirements/Cost
Report No. 10 - Cost of Training

A complete set of reports is provided as an example in Table 29. These reports (1 to 10) address the standard stationkeeping equipment and were developed from the data previously presented in Tables 5, 12, and 17. A review of these reports should be adequate to familiarize the reader with format and content. All codes such as RC (recurring) and NRC (non-recurring) are identified within the text of reports 1, 2, and 3.

## Table 29 LCC REPORTS

REPORT NO. 3 -- SYSTEM COST

PLUP = 15 YEARS          BASE YEAR - 1978

ORIGINAL - ARST STATION KEEPING EQUIPMENT COST DATA - STANDARD
PERTURBED - NOCHANGE

| | ORIGINAL COST | ORIGINAL % LCC | PERTURBED COST | PERTURBED % LCC | DIFFERENCE |
|---|---|---|---|---|---|
| RC - RECURRING | | | | | |
| CS - SUPPORT | 52,950,152.5 | 63.470% | 52,950,152.5 | 63.470% | 0. |
| CO - OPERATION | 0. | 0. % | 0. | 0. % | 0. |
| NRC - NON-RECURRING | | | | | |
| CRD - R & D | 0. | 0. % | 0. | 0. % | 0. |
| CSI - SYSTEM INVESTMENT | 18,685,890.0 | 22.398% | 18,685,890.0 | 22.398% | 0. |
| COI - SUPPORT INVESTMENT | 11,788,884.3 | 14.131% | 11,788,884.3 | 14.131% | 0. |
| CDP - DISPOSAL | 0. | 0. % | 0. | 0. % | 0. |
| LCC - TOTALS | 83,424,927.0 | 100.000% | 83,424,927.0 | 100.000% | 0. |

Table 29 LCC REPORTS (continued)

REPORT NO. 2 -- EXPANDED NON-RECURRING COSTS (NRC)

ORIGINAL - ANSI STATION KEEPING EQUIPMENT COST DATA - STANDARD
PERTURBED - NOCHANGE

| | ORIGINAL COST | ORIGINAL % LCC | PERTURBED COST | PERTURBED % LCC | DIFFERENCE |
|---|---|---|---|---|---|
| RC - RECURRING | 52,950,152.5 | 63.470% | 52,950,152.5 | 63.470% | 0. |
| PIUP = 15 YEARS | | | | | |
| CDP - DISPOSAL | 0. | 0. % | 0. | 0. % | 0. |
| NRC NON RECURRING | | | | | |
| CRD - R & D | 0. | 0. % | 0. | 0. % | 0. |
| CSI - SYSTEM INVESTMENT | | | | | |
| CPP - PROCUREMENT | 18,685,890.0 | 22.398% | 18,685,890.0 | 22.398% | 0. |
| CPM - PROJECT MANAGEMENT | 0. | 0. % | 0. | 0. % | 0. |
| CUI - SUPPORT INVESTMENT | | | | | |
| CPTI - MAINTENANCE TRAINING | 0. | 0. % | 0. | 0. % | 0. |
| CSPI - SPARES | 11,625,288.5 | 13.935% | 11,625,288.5 | 13.935% | 0. |
| CDMI - SE, DEPOT | 0. | 0. % | 0. | 0. % | 0. |
| CSEI - SE, FIELD | 0. | 0. % | 0. | 0. % | 0. |
| CSWI - SOFTWARE ACQUISITION | 0. | 0. % | 0. | 0. % | 0. |
| CJGI - MAINTENANCE MANUALS | 163,166.5 | 0.196% | 163,166.5 | 0.196% | 0. |
| CIMI - INVENTORY MANAGEMENT | 449.3 | 0.001% | 449.3 | 0.001% | 0. |
| CFAI - FACILITIES | 0. | 0. % | 0. | 0. % | 0. |
| LCC - TOTALS | 83,424,927.0 | 100.000% | 83,424,927.0 | 100.000% | 0. |

## Table 29 LCC REPORTS (continued)

REPORT NO. 3 -- EXPANDED RECURRING COSTS (RC)

ORIGINAL - ANSI STATION KEEPING EQUIPMENT COST DATA - STANDARD
PERTURBED - NOCHANGE

| | ORIGINAL | | PERTURBED | | DIFFERENCE |
|---|---|---|---|---|---|
| | COST | % LCC | COST | % LCC | |
| NRC - NON-RECURRING | 30,474,774.3 | 36.530% | 30,474,774.3 | 36.530% | 0. |
| CDP - DISPOSAL | 0. | 0. % | 0. | 0. % | 0. |
| RC - RECURRING (FOR PIUP = 15 YEARS) | | | | | |
| CO - OPERATION | | | | | |
| CFL - FUEL | 0. | 0. % | 0. | 0. % | 0. |
| COP - PERSONNEL | | | | | |
| CAC - AIRCREW | 0. | 0. % | 0. | 0. % | 0. |
| COO - OTHER OPERATIONS | 0. | 0. % | 0. | 0. % | 0. |
| CS - SUPPORT | | | | | |
| COM - ON-EQUIPMENT MAINTENANCE | 8,191,877.9 | 9.819% | 8,191,877.9 | 9.819% | 0. |
| CSM - INTERMEDIATE MAINTENANCE | 6,809,978.6 | 8.163% | 6,809,978.6 | 8.163% | 0. |
| CPT - TRAINING | 2,919,809.4 | 3.500% | 2,919,809.4 | 3.500% | 0. |
| CSP - SPARES | 4,812,479.3 | 5.769% | 4,812,479.3 | 5.769% | 0. |
| CDM - DEPOT MAINTENANCE | 29,995,337.0 | 35.955% | 29,995,337.0 | 35.955% | 0. |
| CSE - SUPPORT EQUIPMENT | 0. | 0. % | 0. | 0. % | 0. |
| CSW - SOFTWARE | 0. | 0. % | 0. | 0. % | 0. |
| CJG - MAINTENANCE MANUALS | 183,539.8 | 0.220% | 183,539.8 | 0.220% | 0. |
| CIM - INVENTORY MANAGEMENT | 37,130.4 | 0.045% | 37,130.4 | 0.045% | 0. |
| LCC - TOTALS | 83,424,927.0 | 100.000% | 83,424,927.0 | 100.000% | 0. |

## Table 29 LCC REPORTS (continued)

REPORT NO. 4 -- COSTS BY SUBSYSTEM CONTRIBUTIONS

RECURRING COST ELEMENTS (PER YEAR)

OUTPUT FILE - AMSE STATION KEEPING EQUIPMENT COST DATA - STANDARD

| ID | COM | CSM | CPI | CSP | CDR | CJG | CIN | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | % RCY | % RCY | % RCY | % RCY | % RCY | % RCY | % RCY | % RCY |
| BAMZSU | 537,295.5 | 346,828.5 | 185,645.9 | 320,831.9 | 1,999,689.1 | 11,635.9 | 2,165.9 | 3,404,097.8 |
| | 15.221 | 9.825 | 5.259 | 9.089 | 56.648 | 0.330 | 0.061 | 96.433 |
| BAMZSU | 8,829.7 | 107,170.1 | 9,008.0 | 0. | 0. | 600.1 | 309.4 | 125,917.3 |
| | 0.250 | 3.036 | 0.255 | 0. | 0. | 0.017 | 0.009 | 3.567 |
| | 546,125.2 | 453,998.6 | 194,654.0 | 320,831.9 | 1,999,689.1 | 12,236.0 | 2,475.4 | 3,530,010.2 |
| | 15.471 | 12.861 | 5.514 | 9.089 | 56.648 | 0.347 | 0.070 | 100.000 |

| | | |
|---|---|---|
| OTHER RECURRING COSTS -- CSE............ | 0. | 0. |
| CSU............ | 0. | 0. |
| CFL............ | 0. | 0. |
| AC............ | 0. | 0. |
| COD............ | 0. | 0. |
| TEST STATION/TEST DRAWER (CSM)....... | 0. | 0. |
| TEST STATION/TEST DRAWER (CPI)....... | 0. | 0. |
| CDR OVERHAUL........................ | 0. | 0. |
| TOTAL RCY...... | 3,530,010.2 | 100.000 |

Table 29 LCC REPORTS (continued)

NON-RECURRING COST ELEMENTS

| ID | CSPI | CAGI | CPP | CINI | TOTAL |
| --- | --- | --- | --- | --- | --- |
| | % NRC | % NRC | % NRC | % NRC | % NRC |
| BAH25D | 11,622,279.5 | 155,145.1 | 18,685,890.0 | 393.1 | 30,463,707.8 |
| | 38.137 | 0.509 | 61.316 | 0.001 | 99.964 |
| BAH25D | 0. | 8,001.4 | 0. | 56.2 | 8,057.6 |
| | 0. | 0.026 | 0. | 0.000 | 0.026 |
| | 11,622,279.5 | 163,146.5 | 18,685,890.0 | 449.3 | 30,471,765.3 |
| | 38.137 | 0.535 | 61.316 | 0.001 | 99.990 |

| OTHER NON-RECURRING COSTS -- | | |
| --- | --- | --- |
| CPTI............ | 0. | 0. |
| CDNI............ | 0. | 0. |
| CSEI............ | 0. | 0. |
| CSWI............ | 0. | 0. |
| CFAI............ | 0. | 0. |
| CRD............ | 0. | 0. |
| CPM............ | 0. | 0. |
| SPRTS.......... | 3,009.0 | 0.010 |
| WNRC............ | 0. | 0. |
| TOTAL NRC...... | 30,474,774.3 | 100.000 |

## Table 29 LCC REPORTS (continued)

REPORT NO. 5 -- COSTS BY LRU CONTRIBUTIONS

RECURRING COST ELEMENTS (PER YEAR)

OUTPUT FILE - AMST STATION KEEPING EQUIPMENT COST DATA - STANDARD

| ID | COM | % RCY | CSM | % RCY | CPE | % RCY | CSP | % RCY | CDR | % RCY | CIN | % RCY | TOTAL | % RCY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DAN251 | 29,585.3 | 0.838 | 9,956.8 | 0.282 | 5,854.6 | 0.166 | 9,606.5 | 0.272 | 80,718.5 | 2.287 | 309.4 | 0.009 | 136,029.1 | 3.854 |
| DAN252 | 211,687.6 | 5.997 | 120,945.7 | 3.426 | 65,381.6 | 1.852 | 205,555.9 | 5.823 | 1,617,676.3 | 45.876 | 309.4 | 0.009 | 2,221,556.6 | 62.933 |
| DAN253 | 283,185.3 | 8.022 | 212,115.4 | 6.009 | 111,389.0 | 3.155 | 102,245.7 | 2.896 | 284,294.3 | 8.054 | 309.4 | 0.009 | 993,539.2 | 28.144 |
| DAN254 | 7,481.3 | 0.212 | 2,655.5 | 0.075 | 1,977.8 | 0.056 | 1,980.7 | 0.056 | 9,610.7 | 0.272 | 309.4 | 0.009 | 24,035.5 | 0.680 |
| DAN255 | 510.1 | 0.014 | 22.9 | 0.001 | 97.0 | 0.003 | 100.8 | 0.003 | 1,031.6 | 0.029 | 309.4 | 0.009 | 2,071.8 | 0.059 |
| DAN256 | 4,333.8 | 0.123 | 1,111.2 | 0.031 | 848.8 | 0.024 | 1,336.8 | 0.038 | 4,267.3 | 0.178 | 309.4 | 0.009 | 14,209.3 | 0.403 |
| DAN257 | 510.1 | 0.314 | 22.9 | 0.001 | 97.0 | 0.003 | 7.5 | 0.000 | 90.6 | 0.003 | 309.4 | 0.009 | 1,037.5 | 0.029 |
| DAN253 | 8,829.7 | 0.250 | 107,170.1 | 5.056 | 9,008.0 | 0.255 | 0. | 0. | 0. | 0. | 309.4 | 0.009 | 125,317.2 | 3.550 |
| | 546,123.2 | 15.471 | 453,998.6 | 12.861 | 194,654.0 | 5.514 | 320,831.9 | 9.089 | 1,999,689.1 | 56.648 | 2,475.4 | 0.070 | 3,517,776.2 | 99.653 |

| | | |
|---|---|---|
| OTHER RECURRING COSTS -- CSE............ | 0. | 0. |
| CSU............ | 0. | 0. |
| CSG............ | 12,236.0 | 0.347 |
| CFL............ | 0. | 0. |
| CAC............ | 0. | 0. |
| COD............ | 0. | 0. |
| TEST STATION/TEST DRAWER (CSM)............ | 0.0 | 0.000 |
| TEST STATION/TEST DRAWER (CPT)............ | 0.0 | 0.000 |
| CDM OVERHAUL............................ | 0. | 0. |
| TOTAL RCY...... | 3,530,010.2 | 100.000 |

## Table 29 LCC REPORTS (continued)

NON-RECURRING COST ELEMENTS

| ID | CSPI | % NRC | CPP | % NRC | CIMI | % NRC | TOTAL | % NRC |
|---|---|---|---|---|---|---|---|---|
| DAN251 | 424,774.2 | 1.394 | 1,863,000.0 | 6.115 | 56.2 | 0.000 | 2,287,830.4 | 7.507 |
| DAN252 | 7,593,069.9 | 24.916 | 7,452,000.0 | 24.453 | 56.2 | 0.000 | 15,045,126.0 | 49.369 |
| DAN253 | 3,273,465.2 | 10.742 | 5,589,000.0 | 18.340 | 56.2 | 0.000 | 8,862,721.4 | 29.082 |
| DAN254 | 88,206.9 | 0.289 | 1,204,740.0 | 3.953 | 56.2 | 0.000 | 1,293,003.0 | 4.243 |
| DAN255 | 25,481.7 | 0.084 | 1,086,750.0 | 3.566 | 56.2 | 0.000 | 1,112,287.9 | 3.650 |
| DAN256 | 215,188.6 | 0.706 | 1,409,670.0 | 4.626 | 56.2 | 0.000 | 1,624,914.8 | 5.332 |
| DAN257 | 1,892.9 | 0.006 | 80,730.0 | 0.265 | 56.2 | 0.000 | 82,679.1 | 0.271 |
| DAN258 | 0. | 0. | 0. | 0. | 56.2 | 0.000 | 56.2 | 0.000 |
| | 11,622,279.5 | 38.137 | 18,685,890.0 | 61.316 | 449.3 | 0.001 | 30,308,618.8 | 99.455 |

OTHER NON-RECURRING COSTS --

| | | |
|---|---|---|
| CPTI........... | 0. | 0. |
| CDRI........... | 0. | 0. |
| CSEI........... | 0. | 0. |
| CSWI........... | 0. | 0. |
| CJGI........... | 163,146.5 | 0.535 |
| CFAI........... | 0. | 0. |
| CND............ | 0. | 0. |
| CPM............ | 0. | 0. |
| SPRTS.......... | 3,009.0 | 0.010 |
| WNMC........... | 0. | 0. |
| TOTAL NRC...... | 30,474,774.3 | 100.000 |

**Table 29 LCC REPORTS (continued)**

REPORT NO. 6 -- RELIABILITY, MAINTAINABILITY, AND AVAILABILITY BY SUBSYSTEM

OUTPUT FILE - ANSI STATION KEEPING EQUIPMENT COST DATA - STANDARD

| SUBSYS | MFHBMA | MTTR | | MTTR/KFH | | MMH/KFH | | AVAIL | SUBSYSTEM LCC CONTRIBUTION | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | FLIGHT | SHOP | FLIGHT | SHOP | FLIGHT | SHOP | | FLIGHT | SHOP |
| BAN25D | 26.30 | 2.985 | 1.833 | 115.306 | 20.443 | 174.388 | 118.920 | 0.89804 | 11,798,819.4 | 73,649,952.0 |
| BAN25Q | 78.00 | 0.300 | 2.500 | 3.846 | 32.051 | 3.846 | 32.051 | 0.99617 | 346,666.0 | 1,790,161.1 |

## Table 29 LCC REPORTS (continued)

REPORT NO. 7

MANHOUR COSTS PER YEAR BY AFSC'S AND SUBSYSTEMS SUPPORTED

OUTPUT FILE - AMST STATION KEEPING EQUIPMENT COST DATA - STANDARD

ANNUAL BASE FLYING HOURS (ABFH) = 21043.80
NUMBER OF BASES (NB) = 6
PERCENT OF TOTAL LABOR DEVOTED TO DIRECT LABOR (EFF) = 60.00%

| AFSC | SUBSYS | LOADED LABOR RATE (LLR N) | DIRECT MMH/FH FLIGHTLINE (FMMH N,M) | TOTAL LABOR FLIGHTLINE (MURF N,M) | DIRECT MMH/FH SHOP (SMMH N,M) | TOTAL LABOR SHOP (MURS N,M) | TOTAL LABOR | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| 32831 | | 7.779271 | | | | | | |
| | DAN250 | | 0.05647 | 1980.624 | 0.04848 | 1700.320 | 3680.945 | 240,938.5 |
| | DAN250 | | 0.00385 | 134.896 | 0. | 0. | 134.896 | 8,829.7 |
| | TOTAL | | 0.06032 | 2115.520 | 0.04848 | 1700.320 | 3815.841 | 249,768.2 |
| 32851 | | 12.759271 | | | | | | |
| | DAN250 | | 0.11351 | 3980.986 | 0.07044 | 2470.566 | 6451.552 | 415,062.7 |
| | DAN250 | | 0. | 0. | 0.03205 | 1124.135 | 1124.135 | 107,170.1 |
| | TOTAL | | 0.11351 | 3980.986 | 0.10249 | 3594.701 | 7575.686 | 722,232.8 |
| 53153 | | 12.759271 | | | | | | |
| | DAN250 | | 0.00841 | 294.987 | 0. | 0. | 294.987 | 28122.73 |
| | TOTAL | | 0.00841 | 294.987 | 0. | 0. | 294.987 | 28122.73 |

## Table 29 LCC REPORTS (continued)

REPORT NO. 8A

SPARES REQUIREMENTS -- INVESTMENT

OUTPUT FILE - AMST STATION KEEPING EQUIPMENT COST DATA - STANDARD

NUMBER OF BASES (NB) = 6
ANNUAL PEAK BASE FLYING HOURS (PBFH) = 56316.80
EXPECTED BACK ORDER (EBO) = 0.10

DEPOT REPAIR CYCLE TIME (DRCT) = 0.17 YRS.
BASE REPAIR CYCLE TIME (BRCT) = 0.13 YRS.

| | SHOP SPARES | | DEPOT SPARES | | UNIT COST | | COST OF LRU SPARES | | COST OF SRU SPARES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LRU | LRU (STKL) | SRU (STKS) | LRU (DPLL) | SRU (DPLS) | LRU (UC) | SRU (UCSRU) | SHOP (LRUSS) | DEPOT (LRUDS) | SHOP (SRUSS) | DEPOT (SRUDS) | TOTAL COST |
| BAN251 | 1 | 6 | 9.28333 | 3.09451 | 6000 | 1000.00 | 6,000.0 | 55,701.2 | 6,000.0 | 3,094.5 | 70,795.7 |
| BAN252 | 1 | 1 | 48.69408 | 35.42681 | 24000 | 2000.00 | 24,000.0 | 1,168,458.0 | 2,000.0 | 70,855.6 | 1,265,311.6 |
| BAN253 | 1 | 1 | 26.07214 | 86.16846 | 18000 | 666.67 | 18,000.0 | 469,298.6 | 666.7 | 57,445.6 | 545,610.9 |
| BAN254 | 1 | 2 | 1.70732 | 1.24492 | 3880 | 1293.33 | 3,880.0 | 6,624.4 | 2,586.7 | 1,610.1 | 14,701.1 |
| BAN255 | 1 | 0 | 0.21341 | 0. | 3500 | 1144.47 | 3,500.0 | 747.0 | 0. | 0. | 4,247.0 |
| BAN256 | 6 | 2 | 0.99593 | -0.71138 | 4540 | 1513.33 | 27,240.0 | 4,521.5 | 5,026.7 | 1,076.6 | 35,864.8 |
| BAN257 | 1 | 0 | 0.21341 | 0. | 260 | 260.00 | 260.0 | 55.5 | 0. | 0. | 315.5 |
| BAN258 | 1 | 0 | 0. | 0. | 0 | 0. | 0. | 0. | 0. | 0. | 0. |
| TOTAL | 13 | 12 | 87.17986 | 126.94608 | 60180 | 7900.00 | 82,880.0 | 1,705,606.1 | 16,280.0 | 134,280.4 | 1,937,046.6 |

TOTAL ALL BASES........................................ 11,622,279.4
OTHER COSTS:
SPARE PARTS (SPRTS).................... 3,009.0
WAR RESERVE MATERIAL COST (WRMC)..... 0.
TOTAL.................................................. 3,009.0

TOTAL CSPI............................................. 11,625,288.4

## Table 29 LCC REPORTS (continued)

REPORT NO. 8B

SPARES REQUIREMENTS PER YEAR -- REPLACEMENT

OUTPUT FILE - AMST STATION KEEPING EQUIPMENT COST DATA - STANDARD

NUMBER OF BASES (NB) = 6
ANNUAL BASE FLYING HOURS (ABFH) = 21043.80

| | MRTS PROB. | CONDEMNATION RATE | | UNIT COST | | COST OF SPARES | | |
|---|---|---|---|---|---|---|---|---|
| LRU | (PM) | LRU (FCL) | SRU (FCS) | LRU (UC) | SRU (UCSRU) | LRU (LRURS) | SRU (SRURS) | TOTAL COST |
| 6AN251 | 0.02610 | 0.01 | 0.05 | 6000.00 | 1000.00 | 1,253.0 | 348.1 | 1,601.1 |
| 6AN252 | 0.13690 | 0.01 | 0.05 | 24000.00 | 2000.00 | 26,289.5 | 7,969.4 | 34,259.0 |
| 6AN253 | 0.07330 | 0.01 | 0.05 | 18000.00 | 666.67 | 10,557.1 | 6,483.8 | 17,040.9 |
| 6AN254 | 0.00440 | 0.01 | 0.05 | 3880.00 | 1293.33 | 149.0 | 181.1 | 330.1 |
| 6AN255 | 0.00060 | 0.01 | 0.05 | 3500.00 | 1166.67 | 16.8 | 0. | 16.8 |
| 6AN256 | 0.00280 | 0.01 | 0.05 | 4540.00 | 1513.33 | 101.7 | 121.1 | 222.8 |
| 6AN257 | 0.00040 | 0.01 | 0.05 | 260.00 | 260.00 | 1.2 | 0. | 1.2 |
| 6AN258 | 0. | 0.01 | 0.05 | 0. | 0. | 0. | 0. | 0. |
| TOTAL | 0.24510 | 0.08 | 0.40 | 60180.00 | 7900.00 | 38,368.5 | 15,103.5 | 53,472.0 |

TOTAL CSP (ALL BASES) -- 320,831.9

## Table 29 LCC REPORTS (continued)

REPORT NO. 9 -- SUPPORT EQUIPMENT REQUIREMENTS/COST

OUTPUT FILE - AMSI STATION KEEPING EQUIPMENT COST DATA - STANDARD

ANNUAL PEAK BASE FLYING HOURS (PBFH) = 56116.00
NUMBER OF BASES (NB) = 6
AVAILABLE ANNUAL OPERATING HOURS (AAOH) = 2080.00

| SE ID | TEST STATION DEMAND TIME (TSDEM) | REPAIR TIME (TSDOT) | UTIL RATE (A) | # PER BASE (NSEB) | UNIT COST (UCSE) | SE COST/BASE (CPUSE) | INITIAL SE SPARES COST/BASE (CSESM) | COST OF INTER-CONNECTION HARDWARE (IH) | COST OF SOFTWARE (CSU) | INVESTMENT COST (CSE1) | REPLACEMENT COST (CSE) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL SHOP PECULIAR SE COSTS PER BASE........... | | | | | | 0 | 0 | 0 | 0 | 0 | 0 |

OTHER BASE LEVEL COSTS:
COMMON SHOP BASE SE COST (BCA)...............
EQUIPMENT INDEPENDENT BASE SE COST (BPA)....
PECULIAR AND COMMON FLIGHTLINE SE (FLA).....
TOTAL OTHER SE COSTS (OBSEC)..........................

TOTAL SE COST PER BASE........................................ 0. 0

CSE1 -- TOTAL NON-RECURRING SE COST (ALL BASES)................................ 0
CSE -- TOTAL RECURRING SE COST PER YEAR (ALL BASES)............ 0
TOTAL RECURRING SE COST OVER USAGE PERIOD OF 15 YEARS.......................... 0

SUPPORT EQUIPMENT LIFE CYCLE COST........................................ 0

Tble 29 LCC REPORTS (concluded)

REPORT NO. 10 -- COST OF TRAINING

OUTPUT FILE - AMST STATION KEEPING EQUIPMENT COST DATA - STANDARD

ANNUAL BASE FLYING HOURS (ABFH) = 21043.80
NUMBER OF BASES (NB) = 6

| AFSC | FTS COURSE LENGTH WEEKS (NWK) | FTS COST/ AFSC (CFTS) | OJT COST/ AFSC (COJT) | MANPOWER REQUIREMENTS (MR) | ANNUAL TURNOVER RATE (TRS) | TOTAL COST |
|---|---|---|---|---|---|---|
| 32851 | 0. | 0. | 2,512.0 | 3.94567 | 0.254 | 3,178.3 |
| 32831 | 30.00 | 19,734.5 | 0. | 1.98742 | 0.674 | 29,127.9 |
| 53153 | 0. | 0. | 2,834.0 | 0.15364 | 0.246 | 136.1 |

TOTAL COST PER BASE.......................... 32,442.3
TOTAL CPT (ALL BASES)........................ 194,654.0
TOTAL RECURRING CPT (PIUP = 15 YEARS)....... 2,919,809.5
NON-RECURRING INITIAL CADRE COST (CPTI)..... 0.
LIFE CYCLE TRAINING COST.................... 2,919,809.5

# VIII. IMPACT ASSESSMENT

## 8.1 OVERVIEW

CHRT provides a complete methodology which facilitates the rational and integrated assessment of human resource, logistics, and cost data with continuity throughout weapon system acquisition. As a result, these assessments may enter the decision process on a collateral basis with performance, operations, budget, and schedule estimates. The impact assessment activity (block E) consists of the gathering and presentation of data developed by other CHRT activities and the use of these data to influence system design and support planning decisions. This section will cover the impact assessment activity and its products, the baseline assessments data group (hexagon 01) and the altenative assessments data group (hexagon 02).

## 8.2 THE IMPACT ASSESSMENT ACTIVITY

The purpose of the impact assessment is to provide the decision-maker with visibility of the impact of possible decisions. The impact assessment activity does not make decisions, it influences them. Specifically, it consolidates the human resources, logistics, and cost information needed to influence specific system design and support planning decisions. When complemented with related design, performance, operations, budget, and schedule data, these data provide a base for fully informed decision-making.

The impact assessment activity consists of three basic efforts for each trade-off under consideration. The first is to review the detailed resource and cost estimates data (ellipses 8 through 14) on appropriate baseline(s) and alternative approaches. The second is to summarize and present these data in a form for use by the decision-makers. The third is to integrate the related performance, operations, budget, and schedule data with the CHRT assessment to provide a complete picture of the total impact.

The terms baseline and alternative are used to describe options and reflect preference for the option. If two options of the same preference exist, they may be defined as either



PRECEDING PAGE BLANK-NOT FILMED

baselines or alternatives. For example, there were two AMST prototypes. While each constituted a baseline for the respective contractor, each constituted an alternative for the Air Force.

Impact assessment has its most effective application in the early phases of acquisition or modification/retrofit. Decisions are made during that time frame which dominate system design and support characteristics throughout the later phases. The purpose of the impact assessment activity during concept, design, and early development is to clearly present the relative merits and identify the unacceptable characteristics of each option. The resource and cost estimates, therefore, must be summarized and presented to the decision-maker in a manner which highlights differences and exposes facets. These unacceptable characteristics or risks may include excessive resource requirements, high costs, low reliability, or poor maintainability. The acceptable criteria for these characteristics are drawn from various program definition documents, such as the system specification or employment plan. They may be expressed as maximum maintenance crew size, an affordability limit, minimum mean time between failure, maximum mean time to repair, and operational availability.

The CHRT manager does not make any decision regarding assessments which exceed these criteria. The manager does, however, review the CHRT input data to verify that they describe the system design and/or support plan, as intended, and that based on available data, the risk is real and not due to faulty data manipulation. After confirming the risk, the CHRT manager may resort to the alternatives data group in an attempt to recommend an alternative for consideration and may also suggest a criteria change.

These procedures were applied at many levels of detail to the assessment of several system design and support plan options during the CHRT demonstration. For example, assessments were performed on two major systems: the two-man flight deck avionics and a modified landing gear. The following trade-offs were also considered for more detailed level subsystem alternatives:

1. Discrete VEH/AM$_5$ and VHF/FM$_6$ radios versus a combined VHF/AM/FM radio.

2. Existing versus modified stationkeeping equipment (SKE).

3. Carbon versus steel brake material.

4. Higher order programming language (HOL) versus assembly language.

Each of the selected system and subsystem designs exhibited a unique system design and/or support planning alternative.

1. The system level designs were evaluated for the conventional versus task-oriented approach, a support planning alternative. That assessment demonstrates the effects of alternative manpower, training, and technical manuals policy on requirements and cost.

2. The VHF radio comparison demonstrates the effect of significantly increased reliability and maintainability standards of requirements and cost.

3. The SKE trade-off demonstrates the effect of modifying a high failure item to reduce both failures and scheduled maintenance.

4. The carbon versus steel brake trade-off demonstrates the effect of a material design decision on requirements and cost.

5. The final comparison, HOL versus assembly language, was selected to demonstrate the impact of a software design approach on acquisition and support costs.

An absolute assessment could also be made and be completely appropriate in the later stages of acquistion or modification/retrofit. At that time, an effectively complete baseline is established and accurate and detailed input data are available. In the case of an absolute assessment, however, the acceptability of the total assessment and the identification of any unfavorable elements are the key factors to be included in the baseline and/or alternative assessment data package presented to the decision-maker.

CHRT may be used to assess the human resources, logistics, and cost impact of any system design or support plan, as long as that design or plan can be reflected in one or more of the assessment techniques available within CHRT. The CHRT manager, however, must determine what assessments are of interest among the baseline(s) and alternatives, and then what assessment techniques are to be used. For example, a system level design trade-off with a rather obvious operations manpower impact is the two versus three member flight deck avionics suit for the AMST (the two member eliminates a navigator but requires more complex equipment). In this case, an operations manpower assessment is the major requirement. The maintenance manpower impact must also be considered and addressed. Is training of maintenance personnel for the more complex equipment a factor that must also be assessed? Is a system ownership cost assessment desired? These decisions are made as part of the program defintion, comparability, and task analysis. The desired assessments are then developed as part of the resource and life cycle cost assessment activities. The resulting data must be summarized and presented. Different alternatives will affect different factors. Commonality of parts, for instance, will directly affect inventory management cost. Improved reliability, on the other hand, will directly affect maintenance manpower and spares. The CHRT manager must ferret this information out of the total estimate package.

The resulting data must also be reviewed for risk or unacceptable impact areas such as high repair times, large maintenance crew size, or excessive costs. The requirements may be too high or possibly some redesign is required. An alternative should be selected which will improve reliability and reduce manpower demand.

Many decisions will result in the need for additional assessments because they will identify new and/or more detailed alternatives. When this occurs, the applicable activities within CHRT are reiterated. Assessments are again generated and summarized for the decision-makers.

## 8.3 PRODUCTS OF THE IMPACT ASSESSMENT ACTIVITY

Impact assessments are made for each baseline and alternative under consideration. Thus, two major data groups are the products of the impact assessment activity: the baseline assessments data group (hexagon 01) and the alternative assessments data group (hexagon 02). Both data groups are retained in the CDB as hard copy. It is the responsibility of the CHRT manager, however, to present these data in a format which will facilitate a decision. The format is variable and a matter of what will best suit the situation. The data groups, format, and content are discussed as follows.

### 8.3.1 Baseline Assessments Data Group

Baseline assessments represent summarizations of significant factors obtained through the resource assessment and life cycle cost assessment activities. The baseline assessment is developed, and a data file is established for each baseline evaluated. Each baseline assessment includes a quantification of the following:

1. System investment
2. Support investment
3. Operating and support costs
4. Disposal costs

There is no specified format for the presentation of the assessment. However, several suggested formats were considered during the CHRT demonstration. Basically, a format which best illustrates the significant factors of interest should be chosen. A sample will be presented in the next subsection.

### 8.3.2 Alternative Assessments

Alternative assessments are also products of the impact assessment activity and include the same categories of information as baseline assessments. Alternative assessments represent significant results drawn from the resource and life cycle cost assessment activities. Separate data files are established for each alternative evaluated. The same flexibility in formatting results is allowed as was allowed for the baseline assessment.

Often it is convenient to present the baseline and an appropriate alternative assessment in a format which facilitates comparison. A suggested format used to compare avionics standard stationkeeping equipment (baseline) against a proposed modifiction (alternative) is shown in Figure 14. This format compares these subsystems in terms of cost, manpower, and technical considerations. The format shown would allow description of risk for each option. However, in this example no risk data are included. The numbered arrows point out significant factors in this assessment.

1. There is a research and development cost for the modified version of $1,000,000.

2. The system investment for the modified version is $1,000,000 less than that for the standard.

## Figure 14 SAMPLE IMPACT ASSESSMENT PRESENTATION

| | | Standard | Modified |
|---|---|---|---|
| 1 | R&D COST (million $) | – | 1,000 |
| | SYSTEM INVESTMENT (million $) | | |
| | Hardware | 18,636 | 17,599 |
| | Project Management | – | – |
| | TOTAL | 16,636 | 17,599 |
| 2 | SUPPORT INVESTMENT (million $) | | |
| | Support Equipment | – | – |
| 3 | Spares | 11,625 | 9,533 |
| | Software | – | – |
| | Maintenance Training | – | – |
| | Maintenance Materials | 0.163 | 0.151 |
| | Inventory Management | 0.001 | 0.001 |
| | TOTAL | 11,789 | 9,684 |
| | MANPOWR FACTORS | | |
| 4 | Maintenance Personnel Total | 34 | 20 |
| | 5 Level | 23 | 13 |
| | 3 Level | 11 | 7 |
| | Maintenance Skills | 3 | 3 |
| | Air Crew Total | | |
| | Officer | | |
| | Enlisted | | |
| | OPERATIONS RISK | | |
| | SCHEDULE RISK | | |

| | Standard | Modified | |
|---|---|---|---|
| OPERATING AND SUPPORT/YR (million $/yr) | | | |
| On Equipment Maintenance | 0.455 | 0.294 | |
| Off Equipment Maintenance | 0.378 | 0.189 | |
| Maintenance Training | 0.195 | 0.114 | |
| Aircrew | – | – | |
| Aircrew Training | – | – | |
| Spares | 0.321 | 0.254 | |
| Depot Repair | 2.000 | 1.315 | |
| Support Equipment Maintenance | – | – | |
| Maintenance Manual Maintenance | 0.012 | 0.011 | |
| Software Support | – | – | |
| Inventory Management | 0.003 | 0.002 | |
| Disposal | – | – | |
| TOTAL/YR | 3.364 | 2.630 | 5 |
| TECHNICAL CONSIDERATIONS | | | |
| Confidence | | | |
| Complexity | | | |
| Risk | | | |
| MMH/FH (S) | 0.15 | 0.08 | |
| MMH/FH (F/L) | 0.18 | 0.12 | |
| MFHBMA (Scheduled) | 78.0 | 400.0 | |
| MFHBMA (Unscheduled) | 28.3 | 40.3 | |
| MFHBMA (Combined) | 19.7 | 36.6 | |
| Availability | 0.8946 | 0.9303 | 6 |

3. Additionally, the spares investment decreases for the modified version.

4. Manpower requirements decrease as well.

5. The operating and support costs for the modified version are approximately $700,000 less than for the standard.

6. The availability of the modified units is .93 as compared to .89 for the standard units.

# IX. PRODUCT DEVELOPMENT

## 9.1 OVERVIEW

The product development activity (block F, Figure 18) is the preparation of the coordinated training and technical manual products data group (hexagon 03). These products define and implement the personnel, training, and technical manual approach discussed by the support plan and reflected in the resource and cost estimates. As such, the product development activity might be termed the "bottom line" of CHRT as a product development methodology. The products prepared also help achieve another goal of CHRT, the more effective use and/or reduction of the personnel required to operate and maintain the system.

## 9.2 THE PRODUCT DEVELOPMENT ACTIVITY

The product preparation activity consists of two basic efforts. The first is applicable in all phases of acquisition. This is the use of the resource assessment output data (ellipses 9 to 15) to fully describe and define the personnel, training, and technical manual program. The results of this first effort may be categorized as definition products. The second effort makes use of the information furnished by the intermediate products data group (ellipse 16) to prepare a coordinated training program and technical manual set. The product development activity, as related to each of these efforts, will be described in the following subsections.

### 9.2.1 Integrated Personnel, Training, and Technical Manual Program Definition Products

The support plan describes the personnel, training, and technical manual logistic support elements among others. In general, the support plan represents an integrated logistic approach and; in particular, it represents a coordinated approach to training and technical manuals. The latter are intended to complement each other and to support a specific personnel concept. The result of such an integrated personnel, training, and technical manual approach is personnel efficiencies (such as improved application of personnel skills and levels and a reduction in personnel requirements).

CHRT, as an assessment-oriented methodology, reflects and quantifies the effect of the personnel, training, and technical manual approach in the resource estimates. Additionally, the training/aiding matrix or the intermediate products, as appropriate, provide visibility into training and technical manual task information coverage requirements.

In early acquisition, assessment is used to define the personnel, training, and technical manual approach described in the integrated logistic support concept or preliminary planning document. As more detailed system design and support planning data become available, iterations of CHRT methodologies provide improved data which are then used to develop the integrated personnel, training, and technical manual section of the integrated logistic support plan. Additionally, information provided in the training/aiding matrix is made available to the training and technical manual specialists so that they may estimate task information coverage requirements and establish priorities or special needs. These additional requirements are then included in the definition documents. Finally, the task information coverage estimates may be extended to estimate the development and/or production phase requirements for training and technical manuals.

As acquisition proceeds and an integrated task analysis is accomplished, the intermediate products are developed and replace the training/aiding matrix. These new products are based on actual equipment analysis and should be used to define and scope the final training and technical manual procurement. The intermediate products used to provide a complete definition of the scope of the training and technical manual requirements should reduce development risk, and also should reduce the cost to develop the coordinated training program and technical manual set.

### 9.2.2 Preparation of the Coordinated Training Program and Technical Manual Set

The coordinated training program and technical manual set are prepared by a contractor utilizing the intermediate products (Section 4.3.6) of the integrated task analysis (Section 4.2.3). The integrated task analysis approach assures that

1. All tasks are considered

2. Appropriate coverage is provided to both training and the technical manuals

3. The training program and technical manuals are tailored for a specific user population

There is no innovative methodology involved in the development of these final products. The innovation is in the use of the single task analysis as a control on information content. The training program and the technical manuals are then developed using standard directives such as AFP 50-58, and MIL-M-83495. As the training program and technical manuals are developed, the possibility of additional analysis and reallocation of task coverage, as well as support equipment improvements, must be allowed and encouraged. If followed, this technique should result in an effective and coordinated product set. One of the obstacles in achieving this effective and coordinated product set is the present procurement method which divides responsibility. The Air Training Command handles training, while the Air Force Systems Command and/or Air Force Logistics Command handles technical manuals, often on separate procurement and occasionally with different contractors. Ideally, the responsibility for procurement should be assigned to a single agency. Realistically, this is not likely. The solution is better coordination among the participating agencies. This can be achieved by mutual acceptance and reliance on the intermediate products developed through the single, integrated task analysis.

## 9.3 THE COORDINATED TRAINING AND TECHNICAL MANUAL DATA GROUP

The coordinated graining and technical manual data group consists of three basic data files: (a) the integrated personnel, training, and technical manual data file; (b) the training products data file; and (c) the technical manual products data file. All are stored in the CDB as hard copy.

### 9.3.1 The Integrated Personnel, Training, and Technical Manual Data File

The data file correlates information from the resource assessment activity and provides definition for the integrated personnel, training, and technical manual approach reflected in the resource assessment. A major data item in this file is the integrated personnel, training, and technical manual section developed for the integrated logistic support plan. Other documentation in this file would include concepts, preliminary plans, statements of work, and program definition statements. All of this documentation is related to the integrated personnel, training, and technical manual question. A sample integrated personnel, training, and technical manual section for an integrated logistic support plan may be found in Reference 24.

### 9.3.2 The Training Products Data File

This file contains the products required for a training course prepared to AFM 50-2 requirements. The major products are:

1. Training plan
2. Training requirement
3. Performance measuring requirements
4. Recommended media
5. Course materials

During the demonstration of CHRT during the full-scale development phase, the intermediate products of the integrated task analysis prepared on the C-141 main wheel brake removal task were used to develop a sample training plan and technical manual set. The samples are task-oriented in nature and were developed to support the performance of flightline tasks by personnel with 3-level skills. This coordinated training plan and technical manual sample set were prepared to implement the task-oriented personnel, training, and technical manual approach reflected in the human resource, logistics, and cost assessments discussed earlier in this report.

The training plan addresses the 431x2 AFSC, Aircraft Maintenance Specialist. The training plan sample was developed using ISD procedures and supports a monitored self-instructional approach. It is oriented toward teaching the use of tools and familiarizing the student with the tasks directly related to the brake change. Emphasis is placed on the more complex tasks and safety. An example of a performance objective contained in the training plan is provided in Figure 15. The complete sample training set may be found in Reference 25.

### 9.3.3 The Technical Manual Products Data File

This file contains the products required under the appropriate technical manual specification. For example, MIL-M-83495 would require:

1. General vehicle manuals
2. General system manuals
3. Job guide manuals
4. Fault reporting manuals
5. Fault isolation manuals
6. Wiring data manuals
7. System schematic manuals

The technical manual sample prepared during the CHRT demonstration is a job guide which addresses the brake removal and replacement task and all the subtasks which must be accomplished. A sample page is provided in Figure 16. During development, emphasis was placed on preparing clearly defined procedures which could be used efficiently by both experienced and inexperienced personnel. The technical manual sample was prepared in job guide format with information presented in a series of major steps and substeps. The major steps are directive in nature and are all that is really needed by an experienced individual. The substeps are primarily informative in nature and are meant as an aid to the less experienced technician. One foldout illustration is included in the sample and provided here as Figure 17. This illustration was developed to depict accurately and realistically the hardware that the technician would handle. The fidelity of the illustration is very important in identifying the various hardware elements. The complete job guide sample may also be found in Reference 15.

REMOVE WHEEL AND TIRE

NOTE: If there is not enough room between the aircraft and axle to remove the wheel, inflate both landing gear struts (refer to T.O. 1C-141A-2-2JG-4).

Figure 15 PERFORMANCE OBJECTIVE SAMPLE

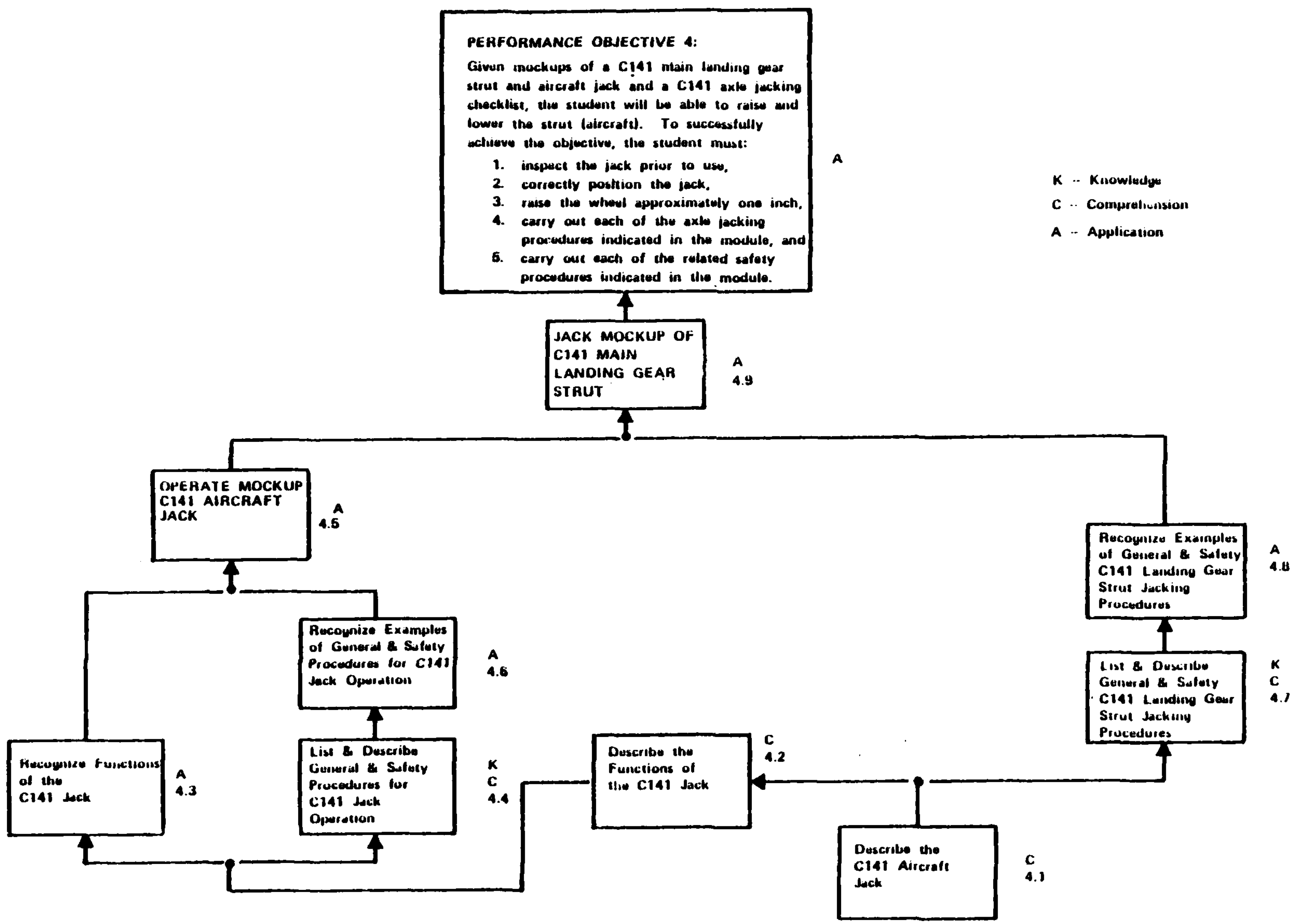


Figure 16 TECHNICAL MANUAL SAMPLE

REMOVE WHEEL AND TIRE

NOTE: If there is not enough room between the aircraft and axle to remove the wheel, inflate both landing gear struts (refer to T.O. 1C--141A--2--2JG--4).

1. Make sure that the parking brakes are off.

2. Remove forward and aft chocks.

3. Disconnect leveler rod (37).
   a. Remove cotter pin (36).
   b. Remove nut (35).
   c. Remove outer washer (34).
   d. Free lever rod by pulling it off of bolt.
   e. Leave inner washer (38) in bolt and put outer washer (34) and nut (35) onto bolt for safekeeping.
   f. Tie leveler rod to forward torque arm so it will not dangle or be damaged.

4. Jack axle until tire clears ground (refer to T.O. 1C--141A--2--2JG--4).

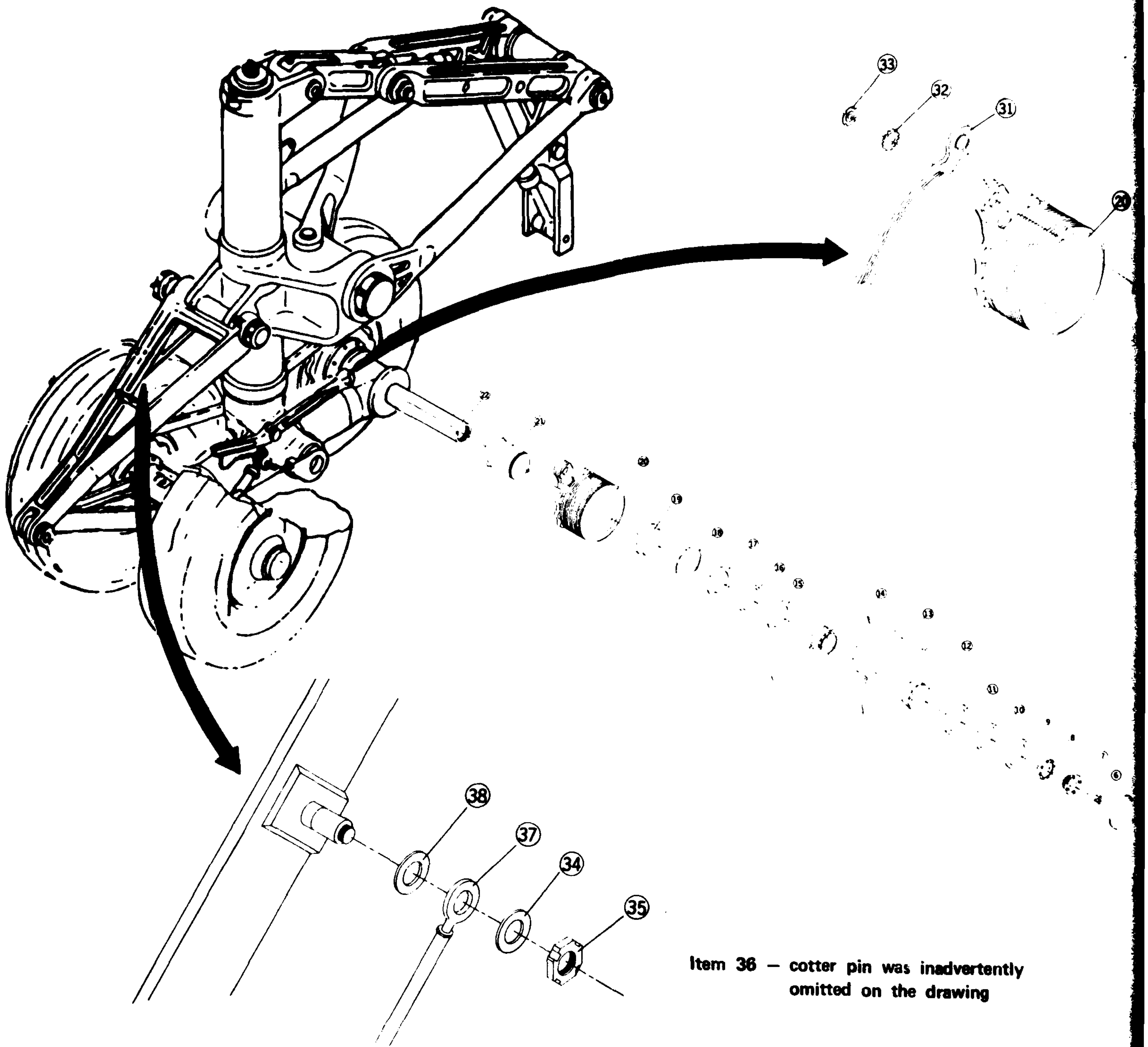
5. Set parking brake.
   a. Depress top part of rudder pedals (40).
   b. Pull out parking brake handle (39).
   c. Release rudder pedals (40).

   NOTE: If parking brake handle will not set in the out position, check to make sure that there is enough hydraulic pressure (refer to T.O.).

6. Deflate tire.
   a. Remove air valve cover.
   b. Use valve core tool to deflate tire until all air is out.
   c. Use valve core tool to remove valve core.

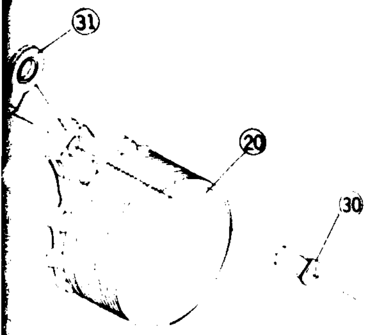
7. Remove outer wheel hardware.
   a. Remove snapring (23).
   b. Remove hubcap (5).
   c. Remove grease retainer ring (9).
   d. Remove felt grease seal (10).

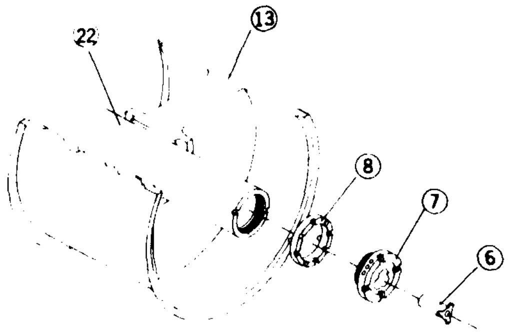
Figure 17 TECHNICAL MANUAL ILLUSTRATION

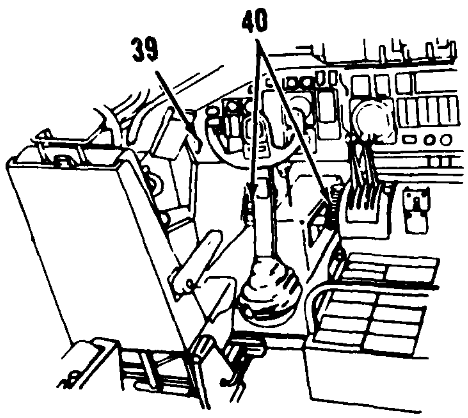



Item 36 – cotter pin was inadvertently omitted on the drawing

LUSTRATION




inadvertently
drawing

1. Make sure that the parking brakes are off.

2. Remove forward and aft chocks.

3. Disconnect leveler rod (37).

   a. Remove cotter pin (36).
   b. Remove nut (35).
   c. Remove outer washer (34).
   d. Free leveler rod by pulling it off of bolt.
   e Leave inner washer (38) in bolt and put outer washer (34) and nut (35) onto bolt for safekeeping.
   f. Tie leveler rod to forward torque arm so it will not dangle or be damaged.

4. Jack axle until tire clears ground (refer to T.O. 1C-141 A-2-2JG-4

5. Set parking brake.

   a. Depress top part of rudder pedals (40).
   b. Pull out parking brake handle (39).
   c. Release rudder pedals (40).

   NOTE: If parking brake handle will not set in the out position, check to make sure that there is enough hydraulic pressure (refer to T.O.).

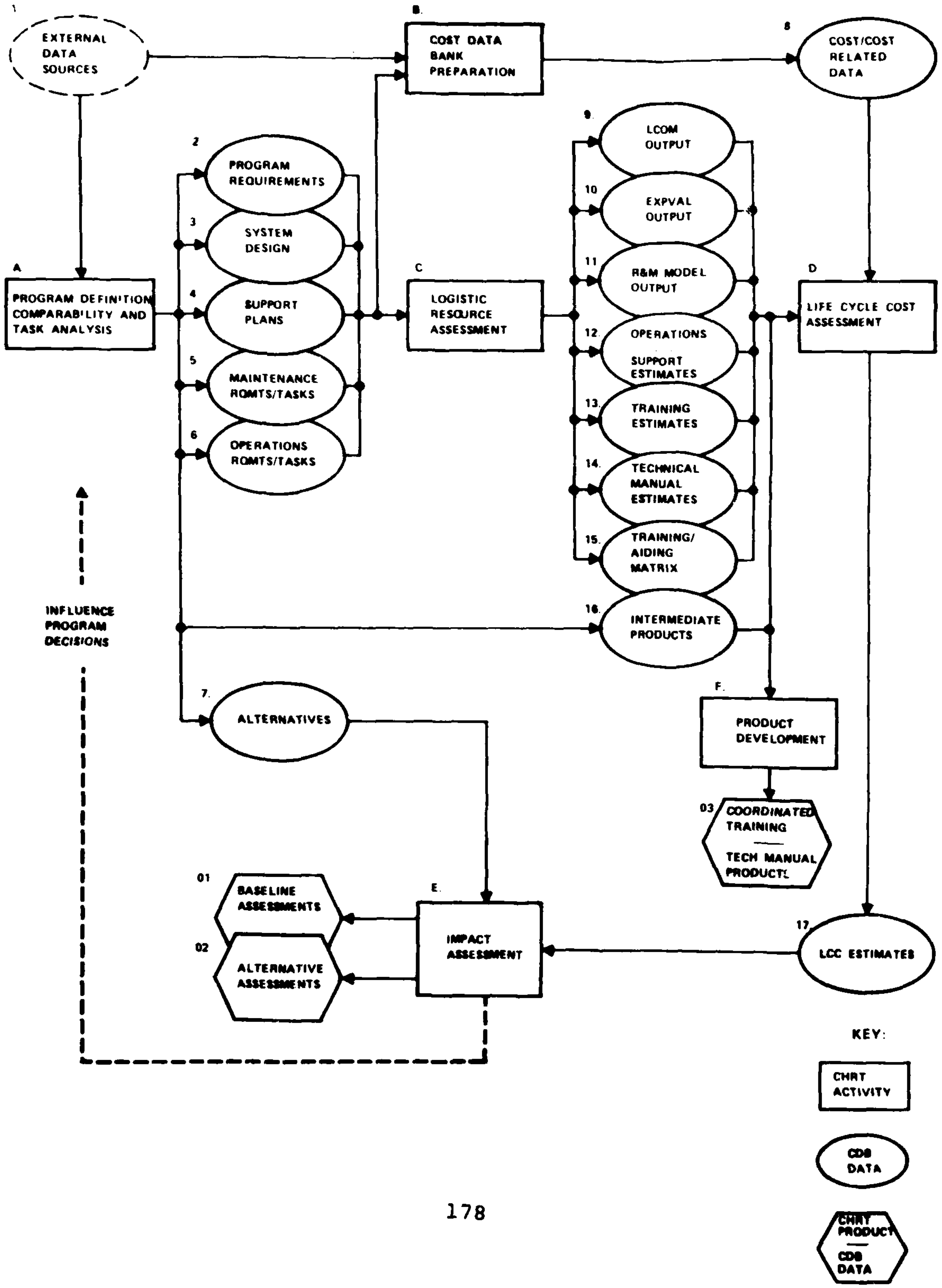
6. Deflate tire.

   a. Remove air valve cover.
   b. Use valve core tool to deflate tire until all air is out.
   c. Use valve core tool to remove valve core.

7. Remove outer wheel hardware.

   a. Remove snapring (13).
   b. Remove hubcap (5).
   c. Remove grease retainer ring (9).
   c. Remove felt grease seal (10).

Figure 18 THE COORDINATED HUMAN RESOURCE TECHNOLOGY ACTIVITIES AND CONSOLIDATED DATA BASE DATA GROUPS



## REFERENCES

The following documents were used in the development of the CHRT process.


1. McManus, J. C. Equipment comparability techniques used during early system design. AFHRL-TR-79-24), AD-A071411. Wright-Patterson AFB, OH: Advanced Systems Division, Air Force Human Resources Laboratory, July 1979.

2. Tetmeyer, D. C. & Moody, W. D. Simulating maintenance manning for new weapon systems: Building and operating a simulation model. AFHRL-TR-74-97(II), AD-A011 987. Wright-Patterson AFB, OH: Advanced Systems Division, Air Force Human Resources Laboratory, December 1974.

3. Tetmeyer, D.C. Comparable item approach to establishing frequency of maintenance and maintenance tasks for a new aircraft (handout). Wright-Patterson AVB, OH: Crew Station Escape and Human Factors Branch, Aeronautical Systems Division, May 1976.

4. Joyce, R. P., Chanzott, A. P., Mulligan, J. F., & Mallory, W. J. Fully proceduralized job performance aids: Volume I - Draft military specification for organization and intermediate maintenance. AFHRL-TR-74-43(I), AD-775 702. Wright-Patterson AFB, OH: Air Force Human Resources Laboratory, December 1973.

5. Joyce, R. P., Chanzott, A. p., Mulligan, J. F., & Mallory, W. J. Fully proceduralized job performance aids: Volume II - Handbook for JPA developers. AFHRL-TR-73-43(II AD-775 775. Wright-Patterson AFB, OH: Air Force Human Resources Laboratory, December 1973.

6. Joyce, R. P., Chenzott, A. P., Mulligan, J. F., & Mallory, W. J. Fully proceduralized job performance aids: Handbook for JPA managers and training specialists. AFHRL-TR-73-43(III), AD-775 716. Wright-Patterson AFB, OH: Air Force Human Resources Laboratory, December 1973.

7. Askren, W. B., & Korkan, K. D. Design option decision tree: A method for systematic analysis of design problems and integration of human factors data. AFHRL-TR-75-9. Wright-Patterson AFB, OH, July 1975.

8. Drake, W. F. & Wieland, B. J. LCOM II simulation software users reference guide. Air Force Management Engineering Agency Report 78-5.1, AFMSMET, Wright-Patterson AFB, Ohio, October 1979.

9. Goclowski, J. C., J. M. Glasier, M. A. Bristol, R. H. Kistler, & H. A. Baran. Reliability, maintainability, and cost model: Technical report. AFHRL-TR-79-65. Wright-Patterson AFB, OH: Advanced Systems Division, Air Force Human Resources Laboratory, September 1979.

10. (Deleted)

11. Air Force Manual 25-5, Management engineering policies and procedures. Washington, D.C.: Department of the Air Force, 8 August 1973.

12. Air Force Manual 26-3, Air Force manpower standards. Washington, D.C.: Department of the Air Force, 27 February 1973.

13. Air Force Regulation 173-10, Cost analysis: USAF cost and planning factors (Volumes I and II). Washington, D.C.: Department of the Air Force, 6 February 1975.

14. Air Force Regulation Pamphlet 177-1, Accounting and finance technical digest (Volume 27, No. 11). Denver, CO: Department of the Air Force, 8 October 1976.

15. (Deleted)

16. USAF. Training cost data package (Letter containing data from Air training command/AM files). 17 February 1978.

17. RIUSAF. Logistics support cost file maintenance register (66-1/IROS, KO51, PN8L). Wright-Patterson AFB, OH. 1976-1977.

18. Department of tahe Navy. Navy military manpower billet cost data for life cycle planning purposes. Personnel Research Division, Bureau of Naval Personnel, NAVPERS-15163, April 1972.

20. Simulation Modeling Consultants, Inc. Expected values model programmer reference manual, 4433 Baker Road, Dayton, Ohio 45424, also ASD/ENESA, WPAFB, OH 45433, April 1980.

21. Czuchry, A. J., Glasier, J. M., Kistler, R. H., Bristol, M. A., Baran, H. A., & Dieterly, D. L. Digital avionics information system (DAIS): Reliability and maintainability model. AFHRL-TR-78-2(I). AD-A056 530. Wright-Patterson AFB, OH: Advanced Systems Division Air Force Human Resources Laboratory, April 1978.

22. Czuchry, A. J., Glasier, J. M., Kistler, R. H., Bristol, M. A., Baran, H. A., & Dieterly, D. L. Digital avionics information system (DAIS): Reliability and maintainability model users guide. AFHRL-TR-78-2(II), AD-A068 826. Wright-Patterson AFB, OH: Advanced Systems Division, AFHRL, April 1979.

23. DRC Advanced Systems Department Staff. Technical order content and cost algorithms (Administrative Report). Wright-Patterson AFB, OH: Advanced Systems Division, Air Force Human Resources Laboratory, 1978.

24. King, G. F., & W. B. Askren. Human resources, logistics, and cost factors in weapon system development: Demonstration in conceptual and validation phases of aircraft system acquisition. AFHRL-TR-79-28(I), AD-A075 272, Wright-Patterson AFB, OH: Advanced Systems Division, Air Force Human Resources Laboratory, September 1979.

25. King, G. F. & W. B. Askren. Human resources logistics, and cost factors in weapon system development: Demonstration in the full-scale development phase of aircraft system acquisition AFHRL-TR-80-52(I). Wright-Patterson AFB, OH: Logistics Research Division, Air Force Human Resources Laboratory, October 1979.

26. ICACI, Extended form 11 processor user reference manual. 1815 North Fort Myer Drive, Arlington, VA, also ASD/ENESA, WPAFB, OH 45433, August 1979.

27. ICACI, Extended form 11 processor programmer reference manual. 1815 North Fort Myer Drive, Arlington, VA, also ASD/ENESA, WPAFB, OH 45433, August 1979.

## GLOSSARY

Algorithms - Mathematical formulas and procedures, preprogrammed into the system, which will translate data from base files and/or subfiles into data elements which quantify human resource requirements and ownership cost.

Baseline Data - Data which reflects the weapon system approved for further developmetn at a DSARC milestone.

Background Data - All weapon system program data from which CDB data is drawn. Behavior - Any human action generally defined by a stimulus (cue) and response. A basic stimulus-organism-response constituent of behavior comprising the smallest logically defineable set of perceptions, decisions, and responses required to complete a task. For example, this involves identifying a specific signal on a specific display, deciding on a single action, activating a specific control, and noting the feedback signals of response adequacy.

Cue - A stimulus to a response. For example, a cue could consist of a meter reading, physical appearance, or flashing light. Responses to cues consist of such activities as turning a knob, setting a switch, or reading a value on a display. Often a resonse can be a cue for a succeeding response.

Data Element - A grouping of information and units which has a unique meaning and which may have subcategories (data items) of distinct units or values.

Data Element Definiton - A narrative defintion of the data element in sufficient detail to present a clear and complete understanding of the precise data or element of information that the data element represents.

Detailed Task Data - Task statements to the level required to make the final training/technical manual decision, to make trade-offs within the instructional system itself, and finally to develop the products: course, media, performance measurement, and technical manuals.

Extended 11 - The format used by the logistics composite model (LCOM) to identify the maintenance tasks and the order in which they are to be done, along with the time and resources needed to accomplish each task.

File - A grouping of one type of input variable or a derived quantity thereof for a particular ID. All of the input data items are grouped for a comparable level (such as flightline, shop).

Job - A group of tasks performed by a specific individual.

General Task Data - Task statements to the level required to make a basic decision regarding manpower requirements and the applicability of training courses, media, performance measurement, and technical manuals.

Line Replaceable Unit (LRU) - A combination of parts, subassemblies, and assemblies mounted together, normally capable of independent operation in a variety of situations. An LRU is normally directly accessible and can be removed without prior disassembly of the equipment or group. (MIL-STD-280). The LRU is the first level of assembly below the subsystem that is carried as a line item of supply at the base level and is usually the highest level of assembly that is removed and replaced, as a unit, on the flightline.

Maintenance Event - Consists of one or more maintenance functions. These maintenance events are specifically shop
A - setup support equipment
T - troubleshoot on aircraft (A/C)
C - cannot duplicate (CND) on A/C
M - minor repair on A/C
R - remove and replace (R&R)
V - verification of R and M events
W - bench check and repair in shop
K - bench check and CND in shop
N - not repairable this station (NRTS)
H - scheduled checks, inspections, or service

Maintenance Function - A behavioral term associated with a task; specifically: adjust, align, calibrate, checkout, troubleshoot, clean, disassemble/assemble, inspect, lubricate, operate, remove/install, repair, and service are maintenance functions (Refer to AFHRL-TR-73-43(I

Reference Data - Data which reflects a reference weapon system. The reference system is the system(s) that the new acquisition will specifically replace and consequently must be shown to be less cost/effective in the long run.

Reference data may be compiled in the conceptual phase and retained as a supplement to the CDB. It would not be expected to change since it is normally derived from operations, performance, support, and cost information on existing systems. In some cases there may be no reference system(s).

Shop Replaceable Unit (SRU) - The SRU is a lower level assembly or subassembly within an LRU normally formed together to perform a specific function. An SRU is normally repaired or replaced only within the base (intermediate level) shops rather than on the flightline.

Skill Level - The fourth number within an AFSC identifying a level of aptitude, training, experience, knowledge, skills, and responsibility.

Subsystem - A set or combination of LRUs and/or assemblies generally physically separated when in operation connected together or used in association to perform an operational function within the system. It is the level of equipment identified by three characters in the work unit code structure (for example, 71B TACAN set) or as a four-digit ID number (for example, AN/2 TACAN).

System - A major subset of a weapon system comprised of individual functional groupings and their integration within the weapon system (for example, avionics, landing gear, or electrical).

Task - A composite of related activities (behaviors) performed by an individual and directed toward accomplishing a specific amount of work within a specific work context. These activities usually occur in temporal proximity with the same displays and controls and have a common purpose. Each task has a goal.

Task Analysis - An analytic process employed to determine the specific behaviors required of a human component in a man-machine system. It involves determining, usually on a time basis, the detailed performance required of men, the nature and extent of their interactions with the machine, ad the effects of environmental conditions and malfunctions. It is the breakdown of behaviors into simple elements of perceptions, decisioins, memory storage, motor output, and so forth.

Task Statement - A statement of the behavioral elements (in action verb form), the cues, and equipment description involved in a task.

Weapon System - A complete system including all equipment, related facilities, material software, services, and personnel required for its operation and support to the degree that it can be considered a self-sufficient unit in its intended operational environment (AFSC DH1-1 page 7, Section 25).

## LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms are used with the CHRT.

| | |
|---|---|
| A | availability |
| A/C | aircraft |
| AFHRL | Air Force Human Resources Laboratory |
| AFSC | Air Force specialty code |
| AMST | Advanced Medium STOL Transport |
| ATIM | annotated task identification matrix |
| CDB | consolidated data base |
| CND | cannot duplicate |
| CHRT | coordinated human resource technology |
| CMT | conditional mean task time |
| CONUS | Continental United States |
| DAIS | digital avionics information system |
| DOD | design option decision tree |
| DSARC | Defense Systems Acquisition Review Council |
| GOR | generalized operational requirement |
| HRDT | human resources in design trade-offs |
| ILS | integrated logistic support |
| ILSP | integrated logistic support plan |
| IOC | initial operating capability |
| ISD | instructional system development |
| JGD | job guide development |
| LCC | life cycle cost |
| LCOM | logistic composite model |
| LRU | line replaceable unit |
| LSA | logistic support analysis |
| LSAR | logistic support analysis record |
| M | maintainability |
| MFHBMA | mean flight-hours between maintenance actions |
| MMH/FH | maintenance man-hours/flight-hour |
| MMM | maintenance manpower modeling |
| MTTR | mean time to repair |
| NRTS | not repairable this station |
| NTIS | National Technical Information Service |
| NTS | nontroubleshoot |
| OI | Office of Information |
| O&S | operation and support |
| O/S | overseas |
| PMP | Program Management Plan |
| PTIM | preliminary task identification matrix |
| QPA | quantity per aircraft |
| RT | reliability |
| R&M | reliability and maintainability |

| | |
|---|---|
| R&R | remove and replace |
| RMCM | reliability, maintainability, and cost model |
| ROC | required operational capability |
| SKE | station keeping equipment |
| SOC | system ownership cost |
| SRU | ship replaceble unit |
| STOL | short field takeoff and landing |
| TETUF | test equipment and tool use forms |
| TS | troubleshoot |
| WUC | work unit code |

END

DATE
FILMED

2 81

DTIC

Cont.

SUPPLEMENTARY

INFORMATION

DEPARTMENT OF THE AIR FORCE
AIR FORCE HUMAN RESOURCES LABORATORY (AFSC)
BROOKS AIR FORCE BASE, TEXAS 78235

Errata

16 JAN 1981

REPLY TO ATTN OF: TSR

SUBJECT: Removal of Export Control Statement

AD-A093353

TO: Defense Technical Information Center
Attn: DTIC/DDA (Mrs Crumbacker)
Cameron Station
Alexandria VA 22314

1. Please remove the Export Control Statement which erroneously appears on the Notice Page of the reports listed [redacted]. This statement is intended for application to Statement B reports only.

2. Please direct any questions to AFHRL/TSR, AUTOVON 240-3877.

FOR THE COMMANDER

Wendell L Anderson

WENDELL L. ANDERSON, Lt Col, USAF
Chief, Technical Services Division

1 Atch
List of Reports

Cy to: AFHRL/TSE